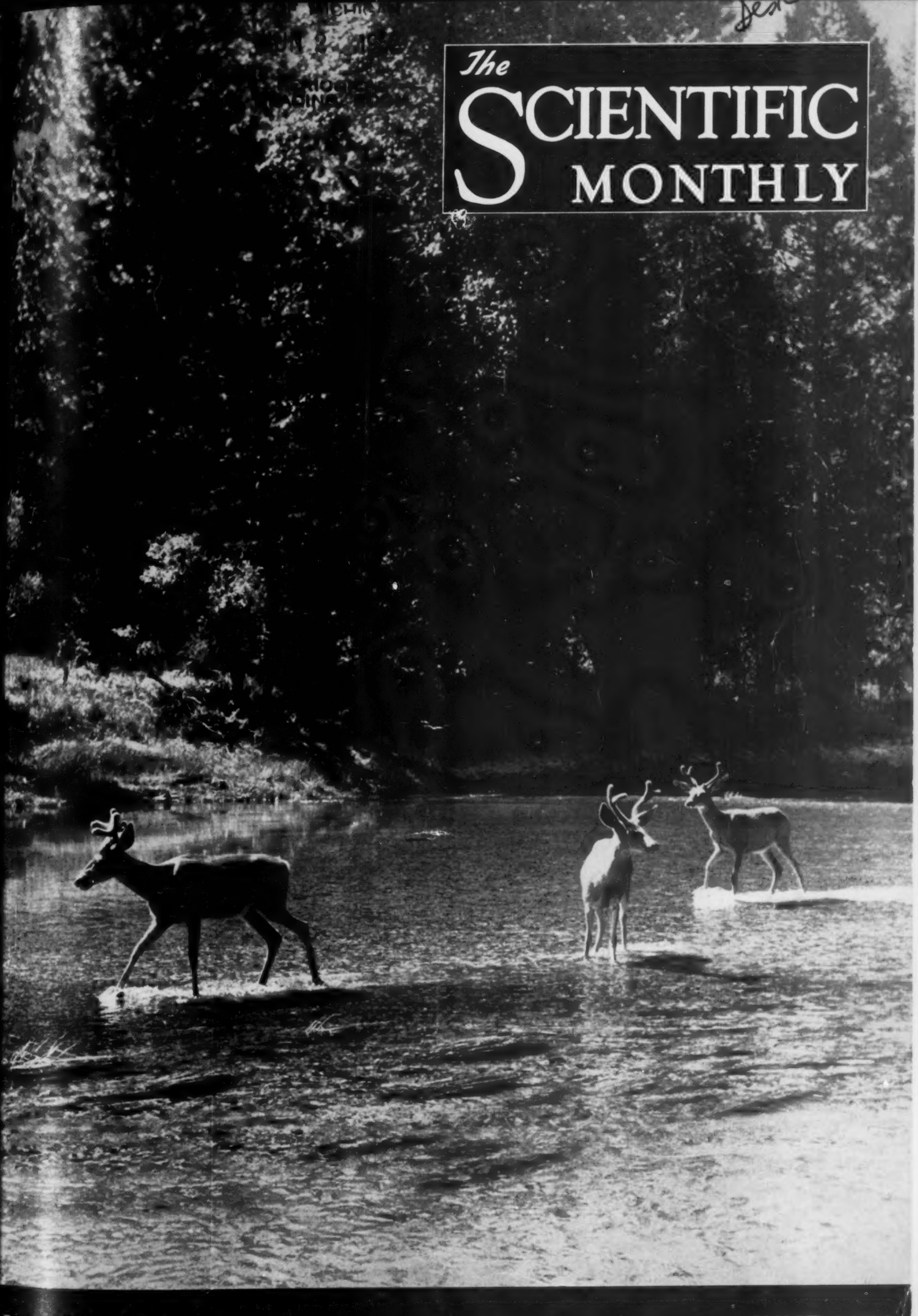
The SCIENTIFIC MONTHLY



VOL. LXXIV NO. 6 JUNE 1952

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THE SCIENTIFIC MONTHLY

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Index Issue

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Science and Technology

(From the Month's News Releases)

Summer's Call

A swimming pool liner of plastic sheeting will provide summer-long fun for a reasonable amount of money—$275, plus $75 for an inflatable bumper (optional). The liner, 27 feet by 13 feet, fits below ground level in an excavation graded from 3 to 5 feet, and has a built-in drain for either a pipe outlet system or sump pump. Smaller or larger pools are available.

A portable cabana made of plastic folds up to the size of a suit box and is designed to reduce tipping, blowing over, or collapsing.

The blue-green algae in small lakes, otherwise suitable for swimming, may soon be controlled by the use of small doses of 2,3-dichloronaphthoquinone. Although the chemical is apparently harmless to fish and other organisms in the water, additional tests are being carried out to determine its effects after long use.

A trailer cooling system, costing approximately $77.00, requires no expensive alterations and is designed to fit over the ceiling ventilator. May be dismounted for traveling.

If you must work, however: New and ingenious hose attachments save nerves, time, and energy. A suction-operated spray mixer mixes commercial fertilizers, weed-killers, insecticides, and detergents with water when attached to an ordinary garden hose. A hose control valve, which operates at the touch of a thumb, fits all standard hose attachments, and will eliminate those tiresome trips back to the faucet. A lawn sprinkler in the form of a flowerpot complete with blossoms, sprays water over a circular area of up to 1200 square feet. A metal spike holds it upright and steady. An aluminum adjustable rake may be used for leaves, grass, and gravel. Salt tablets are inexpensive and easily dispensed from a wall container.

Beakers

A 10-ml blood plasma beaker is an all-Pyrex hollowed-out test-tube type of apparatus, through which a Geiger counter may be inserted for the determination of radioactivity. It is useful in the measurement of small volumes of relatively low activity samples where self-absorption is a factor. A liquid volume beaker has a capacity of 100 ml and is used chiefly for urine assay in radioiodine determinations.

Beaker Bouncer

A resilient mat for use in the bottom of sinks is made of a chemically resistant material on a steel mesh base and is guaranteed not to crack or harden. Stock sizes run from 12″ × 8″ to 30″ × 15″. Special sizes will be made to order.

Tubes of Plastic

At the University of Michigan, the National Sanitation Foundation is embarking on a two-year study of the use of plastic pipes in house plumbing and water supply systems. Major questions to be investigated involve whether water will become impure by contact with specific kinds of plastics; whether plastic erosion will be caused by circulating water; and, if erosion results, what its effect would be on human beings. Reinforced plastic tubing is already being used in various industries for fuel-dispensing lines, electrical conduits, standpipes, and vent tubes.

Biddies at Home

A galvanized steel community hen's nest, 54″ × 35″ × 30″, has partitions and curtains of plastic film and provides laying space for 100–150 hens. Eggs are laid on a sloping metal screen and roll into a separate compartment, where they keep cool, clean, and unbroken. Dirt and manure fall through the screen for easy removal.

Carbon Sandwich

A special carbon-writing surface between two layers of plastic tape permits labeling the easy way. Write on the tape, tear it off the handy self-dispenser, and stick on anything—metal, plastics, paper, any reasonably smooth surface, painted or not. The tape is also available printed to order and comes in five widths, four colors, or with the official AEC radioactive symbol in orange and purple on white at spaced intervals.

Healthier Trees

As soon as the frost is out of the ground shade trees and evergreens should be fertilized with a high-nitrogen fertilizer, taking care not to spill any on the evergreens, which will result in "burned" foliage. Fertilize young trees every year, older ones every three years.

One-Punch Does It

A small compact device similar to the usual punch may be used to punch and reinforce holes in loose-leaf sheets for 2-post ledgers or 3-ring binders in one operation. Small trays catch the confetti produced by the punching process. The reinforcing tape is thin, has a high tear point, and is unaffected by heat, light, cold, or humidity.

Resurfacing

A way to renovate school desk tops makes use of new plastic surfaces attached directly over the old battle-scarred ones with an adhesive that bonds them together practically forever. A light-absorbent, blonde wood-grain laminate is used, thus minimizing eyestrain.

A plastic that comes precoated with adhesive can be used at home to modernize table tops and many other flat surfaces. It is made in rolls and can be bought

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Address a post card to Science and Technology, 1515 Massachusetts Ave., N.W., Washington 5, D. C., for further information about any item on pages iv and v.

at lumber yards and building supply and hardware stores.

Best Seller **Revised**

Prospecting for Uranium, the popular booklet published jointly by the Atomic Energy Commission and the Geological Survey, has been revised to include eight color reproductions of common uranium-bearing ores, the latest official AEC price circulars, and a compilation of public land orders listing tracts withdrawn from public use. The price is 45¢ per copy from the Government Printing Office, Washington 25, D. C., with a 25% discount on lots of more than 100.

Slideasy

A dry, waterproof, stainless lubricant may be used on squeaky or sticky wood, metal, leather, rubber, and plastic surfaces. It contains no grease or soap.

In the Laboratories

On May 2 Fisher Scientific Co. celebrated its golden anniversary with a look at some of the interesting "firsts" of the fifty years that saw it grow from a six-man chemical stockroom in the wilds of western Pennsylvania to a six-plant international concern.

Bell Telephone Laboratories is experimenting with techniques by means of which it hopes to learn more about what man can do with the monster machines he has lately been inventing. A mechanical "mouse," with switching relays like those in dial telephone systems—in reality a two-inch bar magnet with wheels and copper whiskers—threading its way through a series of complicated mazes, can solve a problem by trial and error, remember the solution and apply it later when necessary, add new information to the solution already remembered, and forget one solution and learn a new one when the problem is changed. Bell Labs says its mouse can solve more than a million million different mazes.

Germain Crossmon, head of the industrial hygiene and biological microscopy section of Bausch & Lomb, has developed a technique that makes counts of various types of dust by phase contrast microscopy, a faster and more accurate method than heretofore used.

Chemists at Du Pont are turning out pilot-plant quantities of a new rubberlike material that is completely resistant to ozone. It is heat- and age-resistant and does not need the addition of carbon black. Thus colored fillers may be used. Use of the new product in blends with commercially available elastomers has shown "great promise to date."

"Snake Venoms, and their Mode of Action" was the subject of a seminar held in the Biological Laboratories at Wyeth Incorporated, Marietta, Pa., on May 2 to commemorate the opening of a new laboratory for processing serums, vaccines, antitoxins, and injectable pharmaceuticals. Shown examining one of the reptiles on exhibition are (left to right): George E. Farrar, Jr., Wyeth medical director; B. Scott Fritz, M. Graham Netting, and Nandor Porges.

THE SCIENTIFIC MONTHLY

JUNE 1952

Evaluation of Wildlife Importations

HERBERT W. LEVI*

Dr. Levi (Ph.D., Wisconsin, 1949), assistant professor of botany and zoology at the Wausau Extension Center of the University of Wisconsin, is himself an importation into this country from Germany. He appears, however, to have flourished somewhat better in an alien environment than some of the counterparts of which he writes. He does research in the natural history, taxonomy, and distribution of invertebrates—especially spiders—and has recently been made chairman of the Nature Conservancy's Committee on Exotics.

ALTHOUGH in the past many introductions of exotic animals have been dismal and expensive failures, and the complications resulting from them are legion, the introduction of such animals is still continued. Every decade brings new ideas for making successfully the same introductions that have failed in the past. To some game managers and sportsmen the thought of handling exotic animals is apparently exciting.

Some, evidently encouraged by the success of the transplantation of the pheasant and the Hungarian partridge into the United States, regard previous failures as being due to the haphazard methods used in earlier transplantations. They believe that by careful "scientific" introductions we can improve our gunning. I should like, however, to raise this question: Is it possible to introduce animals scientifically and so avoid failures such as those of the carp, introduced as food fish, and the English sparrow and the starling, introduced for their alleged insectivorous activities?

The dangers, which have to be overcome by scientific methods, are those of bringing in diseases, of hybridization with other animals already present, and of ecological maladaption, including the crowding out of native species.

We are told that a careful quarantine is placed on the birds to be imported.[1] In the past, however, even diseases well known and watched for, like foot-and-mouth disease of domestic animals, have slipped through the quarantine.[2] Others, such as Dutch elm disease (*Ceratostomella ulmi*), along with two bark beetles (*Scolytus scolytus* and *S. multistriatus*), which carry it, have come into this country despite all precautions.[3] A number of birds of a shipment of the recently "scientifically" introduced capercaillie (*Tetrao urogallus*) and black grouse (*Lyrurus tetrix*) died of various parasites before they could be released.[4] In addition, blood smears of those animals that have arrived in Wis-

* I would like to thank all those who helped me: Mrs. C. Crocker, Mrs. K. C. Jones, and J. C. Neess for library work; my wife, who helped in all phases of writing this paper; J. T. Emlen, A. De Vos, N. C. Fassett, Dr. and Mrs. F. N. Hamerstrom, O. J. Murie, and J. C. Neess, who read the manuscript and offered valuable suggestions.

consin have shown that both species are afflicted with a malarial type of parasite.[5] Either the quarantine is ineffective, or the birds did not go through a quarantine, despite assurances that all introductions are subjected to it.

Many diseases are considerably more dangerous to a previously unexposed population than to a population in which the disease is endemic. In the early part of the century the chestnut blight (*Endothia parasitica*) was introduced into the United States. Oriental chestnuts are fairly resistant to the disease and are the culprits suspected of its introduction. It spread rapidly through our susceptible native chestnuts (*Castanea dentata*) in the East and has killed most of them by now.[6,7]

When regions like Australia and New Zealand were first settled, the settlers had little time for exploring and measuring. Then came a day of stock-taking; they found that in large parts of the range native species had been replaced by exotics. This process was a gradual and insidious one, lacking in documentation concerning the effect on the native animals. In Europe and the United States the number of introductions that have succeeded has been small, limiting the examples from which I can choose for this discussion. It should be mentioned, however, that with the introduction of parrots and parakeets we imported psittacosis from the jungles. Parrots and parakeets are fairly resistant to the malady, unless they are in weakened condition, so the disease may not show up, and will slip through the most rigid quarantine. It will eventually infect other animals (including man) that are not resistant to it.[8] No doubt similar diseases exist, although we may not know of them at the present time.

It has also been observed that an introduced animal may leave its parasites at home and, having lost a biological control, become so abundant as to be a pest. This was the case with the Chinese mitten crab (*Eriocheir sinensis*) introduced into Europe. In its native China, this crab is known to have two parasites, a fluke and a species of *Sacculina* (an animal belonging to the barnacle group). Neither of these survives European conditions.[9]

Another example of consequences resulting from an introduction should be mentioned here. As nearly as specialists have been able to determine, the pine root-collar weevil (*Hylobius radicus*) is native to Wisconsin and was here in small numbers living on our native trees. With the introduction of the Scotch pine (*Pinus sylvestris*) it found the tree to its liking and built up its population on this tree. Wherever Scotch pine is planted in central Wisconsin, the insect not only damages the Scotch pine but is also present in large enough numbers to injure the native jack pines (*P. banksiana*) and red pines (*P. resinosa*).[10,11]

The second problem to be considered in introducing exotics is that of hybridization. As a result of the introduction of the bison (*Bison bison*) into European reserves, the pure strain of the wisent (*B. bonasus*) has nearly been lost. New Zealand sportsmen, unable to appreciate native animals as game, introduced the mallard (*Anas boschas* = *A. platyrhynchos*), which is crossing with the native gray duck (*A. superciliosa*).[12] Here, too, should be mentioned the introduction of reindeer near Grant caribou (*Rangifer arcticus granti*) herds in the Alaska Peninsula. Although, according to Murie,[13] the reindeer were introduced to improve the lot of the natives, the natives of Atka Island in the Aleutians utilized the reindeer only when the herds were close to the villages; when the reindeer moved off, the natives lost interest, as they preferred fish. On Umnak Island the reindeer is used as fox bait. But as a result of the introduction on Alaska Peninsula, the Grant caribou has been so intermixed with reindeer that its original characteristics have been considerably altered.[14] In recent years the numbers of both caribou and reindeer in Alaska have been drastically reduced.[15]

Although hybrids are frequently physically stronger as individuals, their fertility may be reduced. Many times, however, the hybrids are not as vigorous as their parents.[16] The transplantation of red deer from southern Europe into Norway resulted in the subsequent extermination of the native race following hybridization.[17] The southern strain of the European gray partridge, when introduced in Scandinavia, interbred with the local population, resulting in a great loss of birds. Apparently the southern strain was not winter-hardy.[17] Similar transplants of Southern and Mexican bobwhite quail have been made in the Northern states. These quail are scantily feathered compared with the Northern ones.[18] Some authors believe this to be a partial cause of the decline of quail (*Colinus virginianus*) in the North.[18,19] After the introduction of red foxes into Sweden, there appeared numerous "Samson foxes" in the Swedish fox population, individuals lacking guard hairs and therefore having less valuable fur.[17]

Two further examples of effects of hybridization should be mentioned. In 1901, the ibex (*Capra ibex*) was reintroduced into the Tatra Mountains, together with two Asiatic species, the bezoar goat

(*C. hircus*) and the Sinaitic goat (*C. nubiana*). All three species interbred. As a result of the crosses the breeding season changed so that the young were born in midwinter, and the offspring perished year after year.[20] A similar occurrence is mentioned by the same author: When the larger Siberian race of the roebuck (*Capreolus capreolus pygargus*) was introduced into Slovakia, it interbred with the native subspecies. The large size of the fetus in the native doe made parturition impossible, and the females perished.[20]

If introductions into the United States must be made, it seems probable that adequate precautions against hybridization can be taken by using only those animals known not to have close relatives in this country. Tinamous transplanted to Georgia some years ago (unsuccessfully) and camels imported by the Army in the middle of the nineteenth century and later liberated in the Southwest, were a far better bet than the recently "scientifically" introduced black grouse and capercaillie. The latter are known to hybridize, not only with each other wherever their range overlaps in Europe, but also with some other species of grouse.[21,22]

In the discussion on ecology to follow, we are not dealing with domestic animals, but only with those introduced to "improve nature," although a sharp distinction can probably not be made, since many of the successful introductions of the past have taken up residence in semidomestic surroundings or in new habitats created by man, and others brought in for domestication have escaped into the wilds.†

One of the common ecological maladjustments is the displacement of native species. Grinnell[25] considered it a natural law that "when a species native to a large area is successfully introduced into a new small area the related species which is native in the area and with which the former comes into competition is soon supplanted." This displacement may be due to hybridization, to the introduction of disease, or to competition for food and cover.

† Enthusiastic advocates of introductions acclaim the excellent results with the acclimatization of domestic animals and plants.[23] They do not consider that cultivated plants and animals exist through "watchful tending and in an artificially sustained environment."[24] Their opinion might be different were the cattle to graze wild in the Eastern forests surrounded by feral pigs, sheep, and goats, or chased by wild dogs, and if chickens were stalked by feral cats. Only one domestic animal has to my knowledge been successfully acclimatized in the wild, without conflict with other interests: the honeybee.

After the crayfish pestilence decimated the European crayfish (*Potamobius astacus*) in the 1870s, various disease-resistant crayfish were introduced as planned introductions. Because of its higher fertility, the Galician crayfish (*P. leptodactylus*) thus introduced displaced the recovering native crayfish. Unfortunately, the introduced crayfish was found to be less edible. Some years later one hundred disease-resistant American crayfish (*Cambarus affinis Orconectes limosus*) were introduced. These crayfish have now populated large parts of Germany, Poland, and France. They are not very palatable, but are replacing the favored European crayfish.[26,27]

The rainbow trout (*Salmo gairdnerii*), when stocked in the Rocky Mountains, has been observed to displace the native species of trout.[28] American gray squirrels (*Sciurus carolinensis*) introduced into England are displacing the native red squirrel (*S. vulgaris*) in that country.[29] In this country the Norway rat (*Rattus norvegicus*) has displaced the earlier introduced black rat (*R. rattus*), although in some parts of the world the two species can apparently live close together in different habitats. According to Errington,[31] introduced pheasants (*Phasianus colchicus torquatus*) and Hungarian partridge (*Perdix perdix*) occupying the same land with the bobwhite quail (*Colinus virginianus*) in Wisconsin have lived at the expense of the quail, whereas the native grouse have not affected the quail population.

While present acclimatizers stress the need for introduction into areas vacant of game at the present time, it should be asked what will prevent an animal once successfully introduced into a "game-vacant" area from spreading out of the area. Even so, the policy is not always carried out, unless the acclimatizers expect the extirpation of the sharptail, ruffed, and spruce grouse in the near future in Wisconsin.

I have heard it said that areas still in natural condition are immune to invasion by exotics, and that all our successful introductions have been made on cultivated land. Probably natural areas are more resistant, and the phenomenal success of the pheasant, which to some minds justifies all further introductions, could not have been possible without farming. In other countries, however, areas left in primitive condition have been invaded by animal intruders, and in the southern part of the United States the forests have been invaded by an introduced plant, the Japanese honeysuckle (*Lonicera japonica*).

Years of intensive study by many students in all

parts of the country have given us a fair knowledge of the ecology of our native animals; many problems still remain unsolved, however. Of the Near Eastern game birds considered for introduction into our Southwest, considerably less is known, and certainly not enough at the present time to make predictions as to their behavior in this country, or to call the introduction "planned." A few seasons' trips by one or two investigators are certainly not sufficient to get complete life history information on a number of game bird species scattered over a large area.

The further assumption is made by the biologists making the introductions that the known habits of transplanted animals do not change. The literature indicates that this is not always the case. In recent years some Rocky Mountain goats (*Oreamnos americanus*) brought from Banff, Alberta, for the zoological garden in Custer Park in the Black Hills, South Dakota, escaped. Although the surroundings in South Dakota are not at all similar to the peaks above timberline near Banff, the goats became established on Mount Harney cliffs and in Ponderosa pine woods, and are apparently doing well for themselves.

A notable case of change in food habits of a native animal after an introduction is that of the kea (*Nestor notabilis*), a New Zealand parrot. Originally it fed largely on carrion, insects, and vegetable matter, but after sheep were introduced the kea developed a taste for meat through feeding on dead sheep, and eventually began attacking live sheep. The parrot now has a prediliction for the fat around the kidney, which it reaches by digging into its victim's back.

The Kentucky cardinal (*Richmondena cardinalis*), introduced into Hawaii, breeds throughout the year, thus raising more broods than in its native haunts. Its numbers have increased remarkably, and the bird is considered by fruit growers to be detrimental.[33] Thomson[12] reports that the Canada goose (*Branta canadensis*), when established in New Zealand, lost its migratory habits. The cosmopolitan rats in Hawaii, under the predatory pressure of mongooses (*Herpestes* sp.) have taken to spending more time in trees. Because of this tend-

Japanese honeysuckle has become a pest in the forests of the southern part of the United States. (Photo by author.)

ency to live in trees they are now a menace to tree-nesting birds, whereas before the introduction of the mongooses their activities were mostly on the ground. The mongooses brought in to control the rats, moreover, are the most serious predators of ground-nesting birds.[33]

The Chinese mitten crab, for which high prices are paid on the market in China, feeds, as far as is known, on worms and decaying material. Its only delinquency is in damage to fish nets; but this is slight and can be prevented by coating the nets. From the description of its habits, one might expect it to be just the kind of animal needed in Europe to add variety to the diet, considering also the absence of native brachyuran crabs in European streams. As it happens, the crab was accidentally introduced into Europe at the beginning of the century and has spread rapidly. Although in Magdeburg over 355 metric tons of these crabs were removed from the Elbe River in 1932, and in other places as many as 10 metric tons were removed daily, they have never found their way to the table; apparently they are unpalatable to Europeans. In Europe the crab prefers for its diet crayfish, insects, snails, and mussels, as well as weakened fish. It does tremendous damage, removing bait from fishing equipment and eating the fish caught in it. The crabs also drill long burrows into the banks of streams and dikes, although no such damage is known in China.[26]

Although in the literature reports of clear-cut changes in habits are few, owing no doubt to lack of careful research, it is common for completely "harmless" plants or animals to become pests when transplanted. The elderberry (*Sambucus* sp.) is one of the worst weeds in New Zealand, as *Opuntia* cactus is in Australia; and *Elodea canadensis* is called *Wasserpest* in Europe.‡ Multiflora rose (*Rosa multiflora*), a planned introduction, has been found to spread into idle land in some parts of the United States, and recently has even been reported as a pest by one worker, like another rose (*R. laevigata*) introduced under similar conditions earlier.[34, 35] In 1905, a few muskrats (*Ondatra zibethicus*) were introduced into Bohemia for sport purposes. In a short time these muskrats, along with others escaped from game farms, had spread over much of north-central Europe, undermining dam walls, embankments, and irrigation canals.[26] Introduction of the musk-

‡ In a list of noxious Bavarian weeds supplied by Johanna Lederer were such species as: New England aster (*Aster novae angliae*) and goldenrod (*Solidago canadensis*).

rat from the eastern United States, where it is a valuable fur animal, into California, produced similarly bad results.[36] In South Africa the American gray squirrel, after being introduced to fill a "vacant habitat" (unoccupied oak trees), seemed to prefer the neighboring orchards.[37] Thomson[12] recorded the valley quail (*Lophortyx californica*), native to and greatly appreciated in California, as a nuisance to farmers in New Zealand.

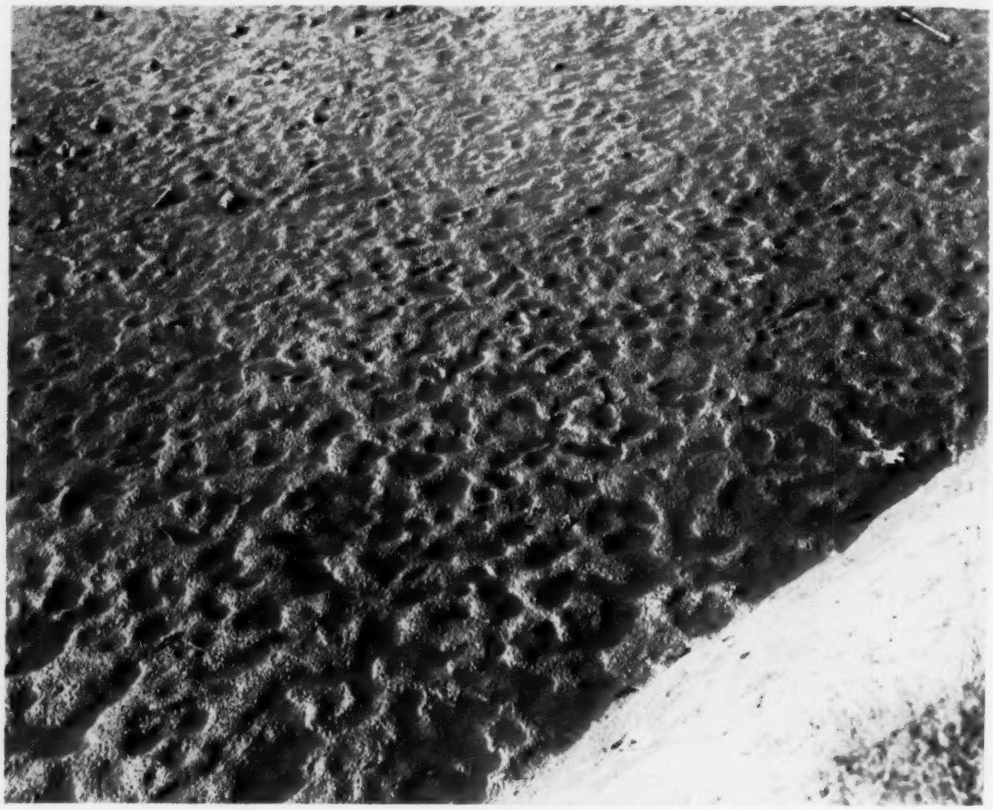
Lantana camara was introduced into Hawaii as an ornamental plant. The mynah (*Acridotheres tristis*), a bird of the starling family, was imported into Hawaii especially to aid in controlling the army worm (*Laphygma exempta*). Lantana is not a pest in Mexico, nor is the mynah a pest in its original home. According to Fisher:[33]

> The individual importations of these organisms seemed harmless. Each importation was made for specific reasons and each might not have been so detrimental had not the other occurred. This is what happened in Hawaii. The mynah fed on army worms as was expected, but it also began to feed on lantana berries, so much so that correlative fluctuations in the abundance of berries and mynahs were observed. The army worm is now seemingly a secondary food item.

The seeds, after passing through the digestive tract of the mynah and some imported doves, are viable, and as a result the plant was spread widely and became one of the most noxious plants in Hawaii.[33]

The carp (*Cyprinus carpio*) the "planned introduction" which was carried out by S. F. Baird, of the Bureau of Fisheries, is one of the most valuable food fish in many countries and is described in *Brehms Tierleben*[38] as having ". . . a soft, juicy and extremely delicious meat . . . are easily acclimatized, will reproduce rapidly and will not interfere in regards to other fish present. . . . They grow rapidly and are easily fattened. . . ." In 1880 the Kaiser awarded Baird a medal for his valuable work. In this country carp has proved itself to be a nuisance rather than the expected valuable food fish. Today literature on carp removal has replaced that on carp introduction in America. The starling is similarly considered a useful insectivorous citizen in Europe (except in recent isolated instances), but a nuisance in this country, where it has become much more abundant than in its original home.

Some biologists say that failures of the past—the "planned introductions" of those days—could have been easily anticipated by a more careful study. This is probably a case of hindsight being more acute than foresight. Mistakes made in recent attempts to introduce capercaillie and black grouse have been mentioned. These birds were introduced carefully into an isolated island on a "planned



A pond in Wisconsin, originally well stocked with a mixed aquatic flora, five months after carp were introduced. The fish have cleaned out every trace of vegetation. (Photo by Wisconsin Conservation Department.)

trial." But black grouse, certainly, and capercaillie, probably, are strong enough fliers to have reached mainland (and may have done so).§ This example well illustrates how difficult it is always to take into consideration even the most obvious problems.

Although our knowledge of ecology may appear to be considerable, we still lack knowledge of, and insight into, all the complexities of environment that could help us forecast the success of artificial transplantation. The factors involved in making an introduction and the chances of its failure or success, of the animals involved becoming game or pests, are as "yet invisible and unknown to science."[39] Rather than new introductions, "scientific" ones, it might be better to spend the funds on some research into past attempts. In many countries there certainly is sufficient material for such research.

The enthusiasts for introductions want to introduce species that will catch on and become sufficiently abundant to stand up under heavy shooting pressure, but the introduced species are not to become weedy. To draw the line between these two conditions is a neat trick of prophecy for a trained ecologist. The strange opinion exists that introduced game animals will never become pests in this country, that such a possibility cannot be conceived of, with an army of several million hunters turned loose against them.[40] But sportsmen have not kept down pests. Although fishermen probably outnumber hunters, they are doing little carp fishing. There is no evidence that an outbreak of black grouse or capercaillie, remote as it may seem, could be controlled by hunters, considering the fact that some authors adjudge the birds under some conditions to be inedible.[41] Although the English government successfully eliminated the invading muskrats escaped from game farms, the only other instance known to me in which an undesirable exotic was exterminated by man (with assistance of the climate and \$7,000,000) is that of the Mediterranean fruit fly (*Ceratitis capitata*) which invaded Florida.[31] Bump takes the precaution of populating just a small area. That does not, however, guarantee that an animal such as black grouse

§ In letters from O. Olstad (Oslo) it was reported that capercaillie can certainly fly the distance involved. L. von Hartman (Helsinki) believes that capercaillie regularly cross the Baltic Sea.

will stay in the area chosen for its introduction. Besides, one might expect the nuisance value not to appear until the introduced animals have reached a reasonable density and, most likely, have spread. Again, one could anticipate disagreement among biologists in determining whether an exotic pest's value outweighs the harm it does. Facts about several of the animals considered as obvious pests, and failures of past introductions, are soft-pedaled by some acclimatizers.‖

According to Bump,[1] only 1 per cent of the possible "world game bank of 355 species and 678 subspecies of game birds exclusive of pigeons, doves, waterfowl and shorebirds" has ever been seriously tried out in this country. Day suggests that some strains of European or Asiatic deer might do well in the "grassy areas of the United States" (presumably the cattle country), whereas native species confine themselves to the wooded sections. According to Hicks,[40] introducing species and following them up will give us "golden opportunities for unraveling the true nature of environments."[5] I do not want to speak here of the aesthetic effect of introducing exotic animals among our own fauna, since not every biologist seems to have the same appreciation of our fauna. Some apparently do not see any objection to converting North America into a zoological garden at the expense of native species.

This project of the Fish and Wildlife Service, which is fundamentally unsound, is a rather unusual policy for an agency that has shown itself as supporting sound conservation practices. In addition, this new policy may encourage other groups, even less careful, to follow the example set and seek permits to introduce hordes of animals on a "scientific basis."

Some game managers and sportsmen are not worried about introductions because, of the many introductions into the United States, only a few have succeeded. Capercaillie have been introduced "scientifically" and unscientifically into the Northern states for sixty years, and black grouse for sixty-five years, even though all this time neither has become established. It should also be remembered, however, that rabbits were unsuccessfully liberated in Australia over a period of seventy-one years, and in New Zealand over thirty-five years,

‖ Day,[23] curiously enough, in defense of introductions, writes as follows: "Few people realize it, but the lowly English sparrow might well be credited with laying the egg that brought forth the Biological Survey, one of the parent agencies of the present Fish and Wildlife Service." One wonders what the Fish and Wildlife Service expects to hatch out of the eggs of capercaillie and black grouse!

Only after thirty-five years did the rabbit succeed in New Zealand—and then only too well. Gullied and eroded hillside, punctured with rabbit holes, somewhere in New Zealand. (Photo by A. H. Clark.)

before establishing themselves.[1] Only after more than half a century of effort were the Australians able to establish the rabbit herds, which then devastated large parts of the continent, thus providing the best example of the possible unforeseen consequences of introductions.

One might close this discussion with a quotation from E. H. Graham,[24] which certainly still holds true: "When a species is introduced into an area where it has not lived before, it is almost impossible to foretell the consequences, although it is quite probable that it will either succeed gloriously or eventually fail entirely."

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PARADOX OF ZENO

Always there is Beyond, a Farther still:
The tortoise still outdistances the hare;
Even Achilles of the wingéd heel
Arrives too late . . . the tortoise is not there
But somewhere farther on, a single pace;
The paradox of Zeno still remains:
The arrow flies, and yet stands still in space;
We move and yet we cannot note our gains.

Is life then an enigma, first to last?
For every "yes" a counteracting "no,"
The future but a segment of the past,
The present, too, an evanescent glow,
Until we come to doubt the very light,
Yet find no answer in the starless night?

Mae Winkler Goodman

Cleveland, Ohio

To the Stars Via South Africa

CHARLES A. FEDERER, JR., and IVAN R. KING

The senior author began his scientific career as a staff assistant and planetarium lecturer at the American Museum of Natural History in 1935. He became a member of the Harvard College Observatory staff in 1941 and editor of Sky and Telescope *in the same year. He recently became chief of the Scientific Literature Branch, Air Force Cambridge Research Center. Mr. King is also a member of the Observatory staff.*

THE year 1751 marked the beginning of astronomy in South Africa. According to Sir David Gill, no serious effort was made to obtain exact knowledge of the southern heavens prior to 1750, except for Edmund Halley's expedition to St. Helena about 1677. Then two hundred years ago a French astronomer, the Abbé Louis de Lacaille, arrived in Cape Town to make measurements to determine the distance of the sun and to make a catalogue of southern circumpolar stars.

Those unfamiliar with the stars might well ask, when told of Lacaille's efforts and those of his successors, why it was necessary to go to the stars by way of South Africa. The question might better be phrased: What observations of the heavens can we make from locations in the Southern Hemisphere that cannot be made from observatories in Europe, Asia, and North America?

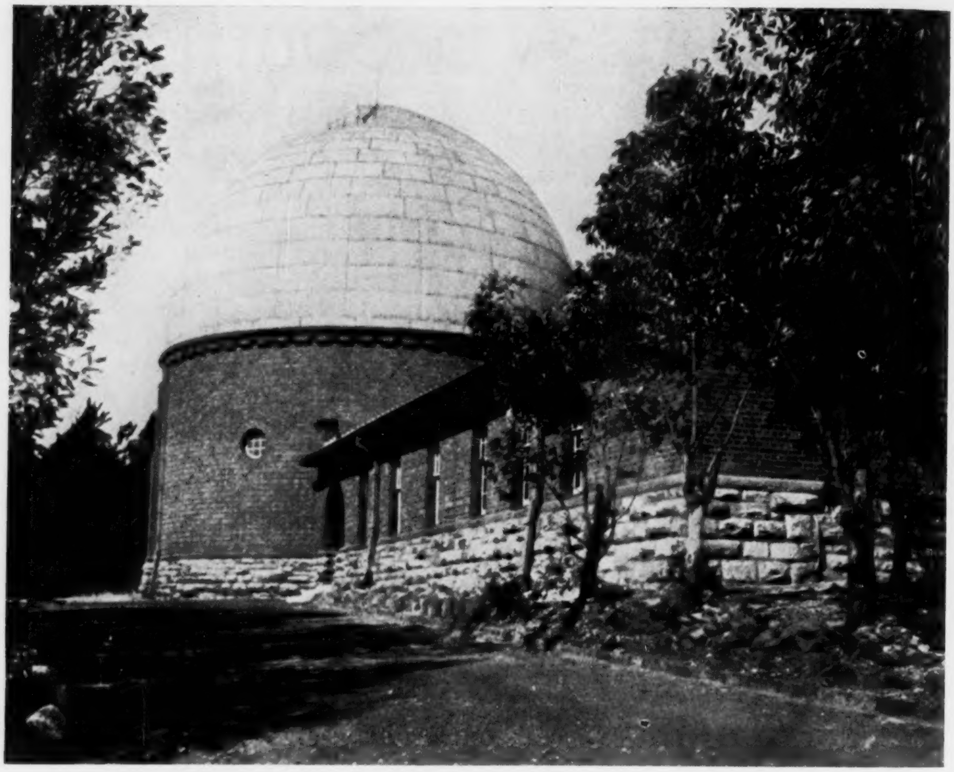
Every observer situated a considerable distance north of the equator has above his northern horizon a circumpolar region of the heavens that is continually visible to him, every clear night throughout the year. As we teach our children, the Big and Little Dippers, Cassiopeia, and Draco are among the constellations that may be seen whenever the night is clear, if one lives in Europe, Canada, or in most sections of the United States. These star groups continually circle the North Star, and for constellation study they form convenient starting points for finding other groups that are farther from the pole and visible only at certain seasons of the year.

For this advantage in having a north circumpolar region, however, we pay the price of being unable to see at all a region of equal size that is centered on the south pole of the sky. At latitude 38° north, that of Washington, D. C., the invisible south circumpolar region has a radius of 38 degrees, so that is is impossible from the United States Naval Observatory to see about one fifth of the entire celestial sphere. In addition, another fifth never rises high enough above the southern horizon to make favorable observing possible. The 200-inch telescope on Palomar Mountain in California is more favorably situated in this respect, for its latitude is 34° north, and the invisible region is correspondingly smaller. The new 98-inch Isaac Newton memorial telescope under construction at the new Royal Greenwich Observatory at Herstmonceux Castle, England, cannot see a region nearly 51 degrees in radius.

Ever since such voyagers as Magellan described the beauties that blazed down from overhead as they traveled around the extremities of South America and Africa, astronomers have been aware of the glories of the invisible regions. To early explorers, the changed aspect of the heavens must have been a mystery nearly as great as that of the new lands and seas they investigated so courageously. But astronomers have until comparatively recent times been so busy scanning the available heavens with telescopes and other instruments close at home that they have had little time or enthusiasm for expeditions to the Southern Hemisphere.

Proper atmospheric conditions are not the only prerequisite for the selection of a site where a permanent southern observatory may be established, and all directors of northern observatories who have sought to extend astronomical research to the southern sky have had to meet a variety of problems. Whereas an expedition to observe an eclipse of the sun may travel to the remotest corners of the earth, large and permanent telescopes require constant supplies of photographic plates and materials, auxiliary instruments, and other items that can be easily provided by the mother observatory. Modern installations need electricity and water, and the personal and social requirements of astronomers and their families must be taken into consideration.

The South Africa of today—a young and growing country developed chiefly during the present century—offers a good combination of sky conditions and living amenities, and it is no wonder that astronomical migrations have led to the interior of that country, where elevations up to 6000 feet are easily accessible. In this respect, South Africa some-



Dome that houses the 26½-inch refractor of the Union Observatory, Johannesburg, South Africa.

what resembles California with its Coast Range relatively near centers of population.

It was for the benefit of nineteenth-century navigators that the Royal Observatory of the Cape of Good Hope was established, not long after the English had acquired the Cape from the Dutch in 1814. Located a few miles from Cape Town, on a height from which it was expected signals could be sent to ships in Table Bay, the new observatory provided a time service and other aids to navigation. One of its first directors, Thomas Henderson, is famous for his early measurement of the distance of the nearest star, Alpha Centauri, from observations made at the Cape Observatory. In addition to a standard program of meridian astronomy in its various phases, this observatory began in 1926 to measure the distances to relatively nearby stars, on parallax plates taken with its 24-inch Victoria photographic refractor. Under the present director, R. H. Stoy, the observatory is carrying out a broad program on the magnitudes of southern stars. During 1949 the sun was photographed on 360 days of the year, a new record even for this favorable location.

In 1834 Sir John F. W. Herschel, son of the famous astronomer who discovered Uranus, arrived in Cape Town on a private four-year expedition. With a large telescope, he set out to catalogue the nebulae of the southern sky on the same plan as that used earlier by his father for the northern nebulae. Herschel's was the first of a series of expeditions and projects that in some cases have led to the establishing of permanent Southern Hemisphere observatories.

In 1910 the government of the Union of South Africa established in Johannesburg the Union Observatory, whose equipment includes a 26½-inch refractor. This institution, under the direction of W. H. van den Bos, is maintained by the government's department of education, and concentrates on double stars, comets, asteroids, and the operation of the country's time service. The Union Observatory maintains close relations with the Leiden Observatory in Holland, which has set up and operates a large photographic and visual double refractor at the Union Observatory. The Leiden southern observers have concentrated mainly on variable stars.

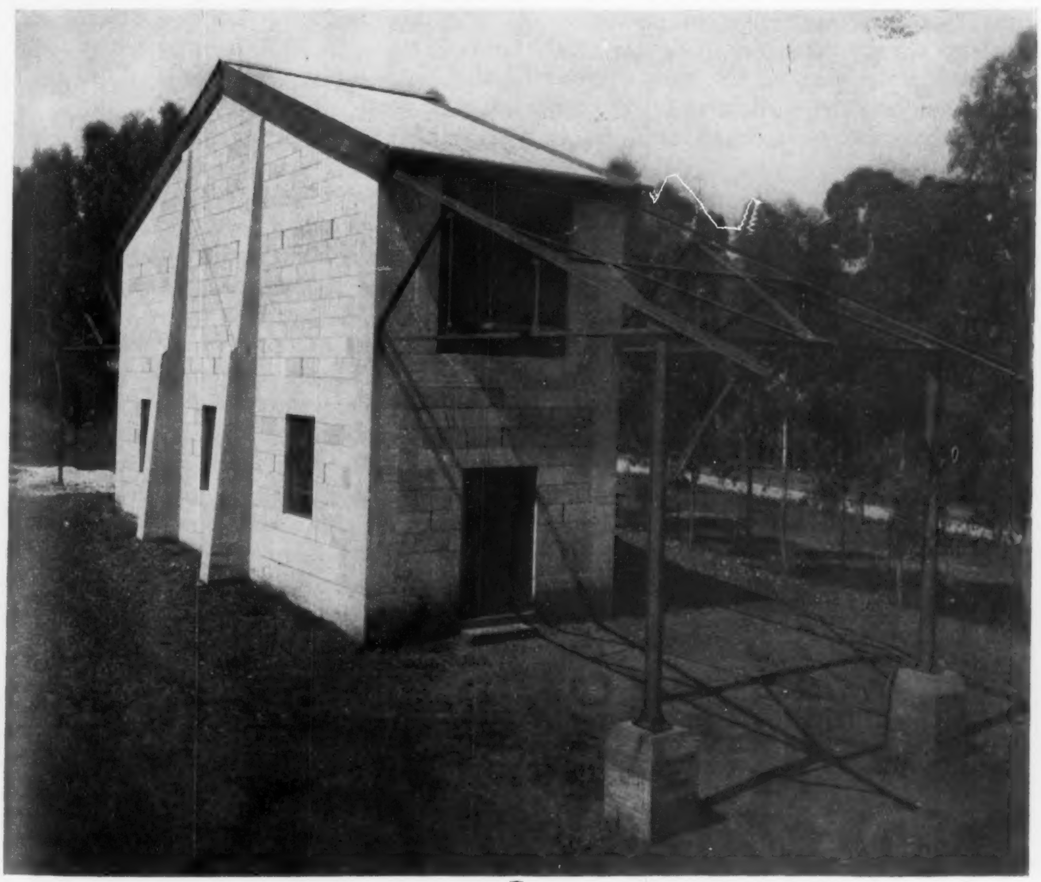
Also at the beginning of the twentieth century, in the same era of astronomical expansion that included the building of the world's largest refracting telescope at the Yerkes Observatory in Wisconsin and the first observations from Mount Wilson in California, visitors began to investigate astronomi-

cal conditions in South Africa. The Dutch astronomers J. C. Kapteyn and W. de Sitter visited the country, and in 1908 Solon I. Bailey, of Harvard, spent a year traveling from Cape Town to Bulawayo in Southern Rhodesia. His object was to find the most suitable spot for the transfer of the southern branch of Harvard Observatory that had been in operation since 1889 at Arequipa, Peru. Later visitors to South Africa who had the establishment of observing stations in mind were Charles G. Abbot, of the Smithsonian Institution; W. J. Hussey, of the University of Michigan Observatory; Frank Schlesinger, of Yale University Observatory; and Ejnar Hertzsprung, of the Leiden Observatory.

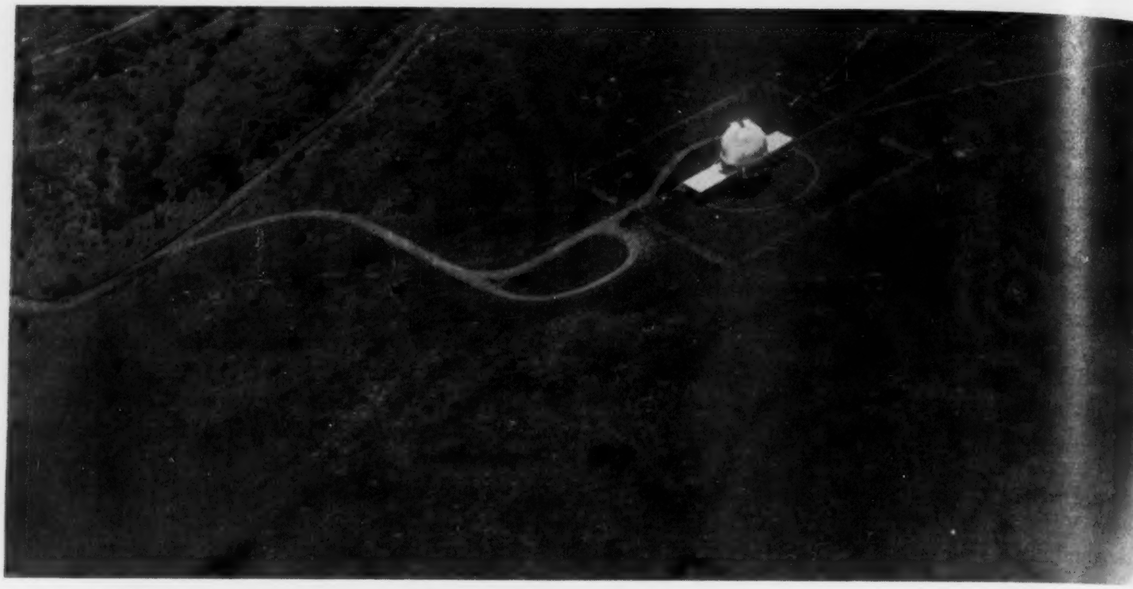
Thus it came about that, in a span of three years, four American observatories were set up in South Africa. In 1925 Yale's southern station, later known as the Yale-Columbia Station, was established in Johannesburg. This was followed in 1926 by a solar observing station of the Smithsonian Institution on Mount Brukkaros, South West Africa, and the Lamont-Hussey Observatory of the University of Michigan, in Bloemfontein. Finally, in 1927, the Boyden Station of Harvard Observatory was removed from Peru to Mazelspoort, near Bloemfontein; this transfer was carried out completely by the late J. S. Paraskevopoulos, who was superintendent of the Boyden Station from 1923 until his death early in 1951. The Mount Brukkaros Station operated only five years, but the other South African observatories became permanent institutions.

The Yale southern station marked the fulfillment of one of the major ambitions of Frank Schlesinger, the astronomer who established the photographic techniques by which we measure the distances to the nearer stars. These trigonometric parallaxes require telescopes of great focal length, to give large scale to the photographs. Thus it was that Dr. Schlesinger built for South Africa a 26-inch photographic refractor of 36-foot focal length. To this are attached one 10-inch visual refractor of the same focal length, and one 5-inch camera.

The main program of the Yale southern station, now under the direction of C. Jackson, has been



Building in which the 26-inch refractor of the Yale-Columbia Station, Johannesburg, is located. Roof slides off in two parts, to the north and south. The field of observation is restricted to regions close to the meridian because the instrument is used for parallax measurements.



The University of Michigan's Lamont-Hussey Observatory at Bloemfontein, from the air. This observatory dates back to 1927. (Photo by M. K. Jessup.)

to determine distances and apparent motions of southern stars, the characteristics of double stars, and to catalogue the stars on the basis of their positions and motions. One such catalogue recently completed at New Haven involved measures of 128,000 stars, mostly on plates taken in South Africa.

In 1946 Columbia University became a copartner, and its Department of Astronomy began to use half of the 26-inch telescope's observing time to determine reliable colors of selected southern stars. As the city of Johannesburg grows, however, astronomical observations there are becoming more and more difficult. The Yale-Columbia Station has consequently decided to move to Australia, where it will be part of a cooperative project in the astronomical "preserve" of Mount Stromlo Observatory, near Canberra.

Another lifetime dream was that of William Joseph Hussey, former head of the Astronomy Department at the University of Michigan—to build a large refractor to observe double stars in the Southern Hemisphere. The dream came true through funds furnished by Robert P. Lamont, of Chicago, for building and maintaining a 27-inch visual refractor.

Late in 1923, Dr. Hussey, equipped with a 10-inch telescope, arrived in South Africa in search of a site. He finally selected Naval Hill, within the city limits of Bloemfontein. He returned to the United States to prepare the final expedition, which left New York in October 1926. On the way, Dr. Hussey died suddenly in London. The responsibility was taken over by R. A. Rossiter, who by 1928 had completed the new observatory. At the beginning of 1937, fears were expressed that this branch of Michigan Observatory would be obliged to close down, but the government of the Union of South Africa generously provided funds to continue the work.

The program at the Lamont-Hussey Observatory has recently been broadened to include the southern "hydrogen-alpha" survey, a joint project of the Michigan and Mount Wilson observatories. On red-sensitive photographs made with a 10-inch prismatic camera, those stellar spectra stand out in which the hydrogen-alpha line is bright. Since most spectra do not contain this bright line, an inspection of the photographs serves to reveal those objects which do, including gaseous nebulae and stars with hot, deep atmospheres. Since the northern survey, made at Mount Wilson Observatory, is already complete, these southern observations will round out a survey of the entire sky.

The Boyden Station of Harvard Observatory has instruments that complement those at its main observatory in the town of Harvard, Massachusetts, where there are counterparts of the Boyden Station's 60-inch Rockefeller reflector, 13-inch Boyden refractor (both visual and photographic), 10-inch Metcalf triplet, 8-inch Bache refractor, and several small patrol cameras. Harvard's collection of photographic plates of the sky is approaching the half-million mark; not least in importance are those

pictures taken regularly every clear night in South Africa by small, unguided patrol cameras that keep watch on the sky for events that elude the larger instruments with their smaller fields of view.

The station's potentialities have been further increased by the installation of a photoelectric photometer and a spectrograph, for use on the 60-inch reflector. And a major transformation now in progress is the turning of the 60-inch into a giant Schmidt-type telescope; the new mirror has already been manufactured in the United States. But the greatest change took place in the fall of 1950, with the arrival at Mazelspoort of a new telescope of Baker-Schmidt design, to be operated jointly by Armagh Observatory, North Ireland; Dunsink Observatory, Eire; and Harvard Observatory. This instrument has been installed on the mounting of the retired 24-inch Bruce refractor—long one of the most important instruments in the south. The so-called ADH telescope has a 36-inch primary mirror and a 32-inch correcting plate; a 17-inch convex secondary mirror completes the optical arrangement that produces a flat focal plane on photographic plates covering about 20 square degrees of the sky. Bart J. Bok, associate director of Harvard Observatory, who was in charge of the installation of the ADH, spent about eighteen months during 1950–51 in South Africa using it to investigate the structure of the southern Milky Way. Dr. Bok returned with several hundred photographs of more than a million stars. Analysis and interpretation of this great mass of data are expected to take at least three years.

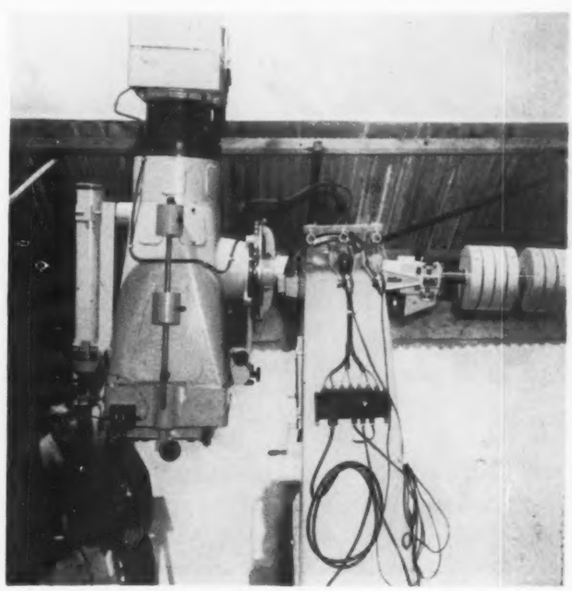
Harvard's work at the Boyden Station is concerned chiefly with the southern Milky Way, southern galaxies, and those special neighbor galaxies, the Large and Small Magellanic Clouds. Also recently completed is a repetition of plates taken forty years ago in Arequipa, Peru, in order to determine the apparent motions of faint stars.

One of the world's largest reflecting telescopes, 74 inches in diameter, was put into operation about three years ago at the Radcliffe Observatory in Pretoria. This English observatory was originally established nearly two centuries ago at Oxford, but when plans made within the past generation for a large reflector called for a transfer to better skies, the observatory decided to meet the great need for a southern instrument devoted to spectroscopy. At present, while accessories so essential to the efficient programming of such an instrument are being procured, it is engaged in direct photography of nebulae and other distant objects, under the direction of A. D. Thackeray. The problem of the rotation of the Milky Way is to be studied further at the Radcliffe Observatory, as practically all our facts concerning the motions of very distant stars have been obtained at northern observatories.

In an observing expedition to South Africa, John Irwin, of the Indiana University Department of Astronomy, took with him a photoelectric photometer with which to make observations of magnitudes and colors of southern stars and star clusters, as well as of the polarization of the light of these objects. He attached the photometer to the 74-inch Radcliffe reflector, to the Lamont-Hussey 27-inch refractor, and to the 24-inch Cape refractor, moving from one observatory to another so as to interfere as little as possible with their regular programs.

By far the most striking feature of the southern skies is the chaotic splendor of the Milky Way. This irregular band encircles the entire sky from north to south and back again, but its brightest parts are far to the south. The incomparable star cloud in Sagittarius, which at the latitude of Washington, D. C., never rises high enough to show itself to full advantage, passes directly overhead during the long, clear South African winter nights, and it is blotted out only by the brightest moonlight.

By contrast with much of the northern Milky Way, this region is not a smooth band of light but is torn in many places by dark lanes that we know to be great clouds of dust concealing the distant parts of our galaxy. And here we find one of the strongest lures for the northern astronomer: the galactic center and the interesting stars and star



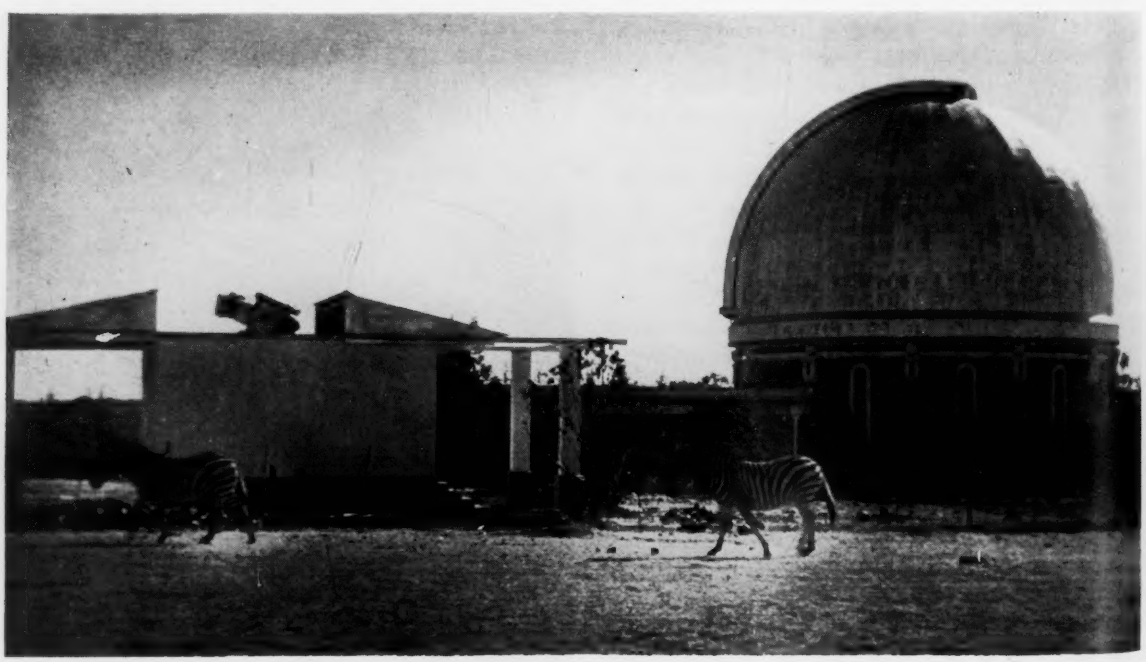
Close-up of the 10.5-inch prismatic camera at Lamont-Hussey. It was first used at Mount Wilson.

groups that are most numerous in the direction of the center. As an example, we may cite the globular star clusters, whose very preference for the Sagittarius region of the sky led thirty years ago to the discovery of the center of the galaxy. The two brightest globular clusters, Omega Centauri and 47 Tucanae, are easily visible to the naked eye as fuzzy spots in the sky, and a large telescope reveals each to be a great collection of tens of thousands of stars.

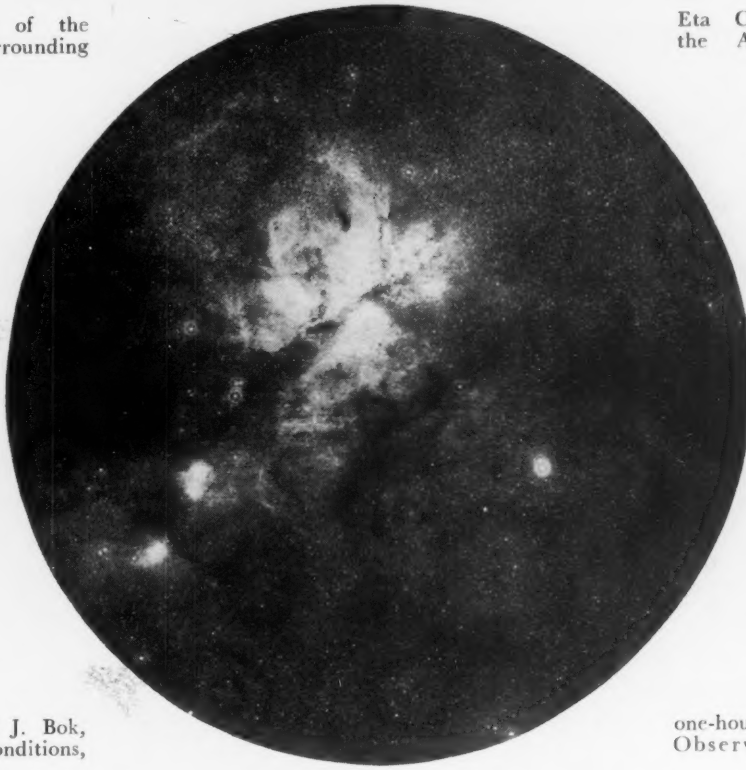
In one direction, the Milky Way fades from the Sagittarius cloud to the familiar star clouds of our northern summer sky, but in the other direction lie brilliant regions that never show themselves above our horizon in the north. Current attempts to trace a spiral structure in our part of the galaxy depend heavily on studies of such regions as the Carina cloud, rich in gaseous nebulae and the pulsating stars known as Cepheid variables. And all through this region are scattered bright blue stars, distant skymarks of galactic structure. There, too, is Alpha Centauri, a triple system which is our nearest neighbor among the stars; the Southern Cross, pointing to the otherwise unmarked south pole of the sky; the Coalsack, a dust cloud that makes a black "hole" in the Milky Way.

Seven hours after the Sagittarius cloud has passed overhead in South Africa, the aspect of the sky has completely changed. The Milky Way circles the horizon and is nowhere high enough to be conspicuous. Overhead is a relatively blank region of no apparent interest. But even here important astronomical work is to be done, for this is the direction at right angles to the plane of the Milky Way galaxy, and we can look far out into space without serious obstruction by the dust clouds that hinder our view along the Milky Way plane (galactic equator). Here, in the direction of the south pole of the galaxy, apparent star brightnesses need no correction for the effect of interstellar absorption, and we can see countless distant galaxies that are the chief population units of the universe as a whole.

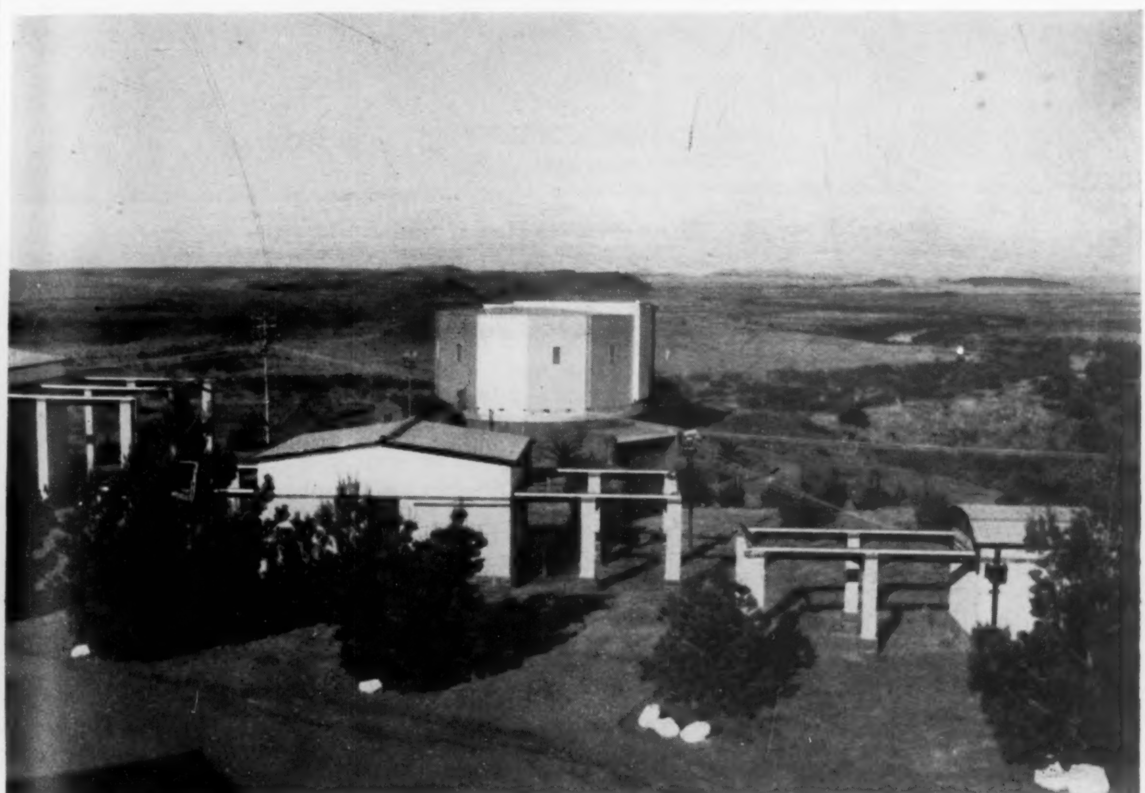
Farther south are the two Magellanic Clouds, which look like isolated patches of the Milky Way. Although galaxies in their own right, they are probably satellites of our own galactic system. Their great importance is that they are close enough to us that we can study their individual stars but are still far enough away that we can consider all their stars to be at about the same distance from us. We recognize in the Magellanic Clouds many familiar types of stars and other objects, and we can compare them with one another on an absolute basis. It was in the Small Magellanic Cloud that the relation of the intrinsic brightnesses and the periods of Cepheid variable stars was first established: relatively faint Cepheids pulsate rapidly, bright



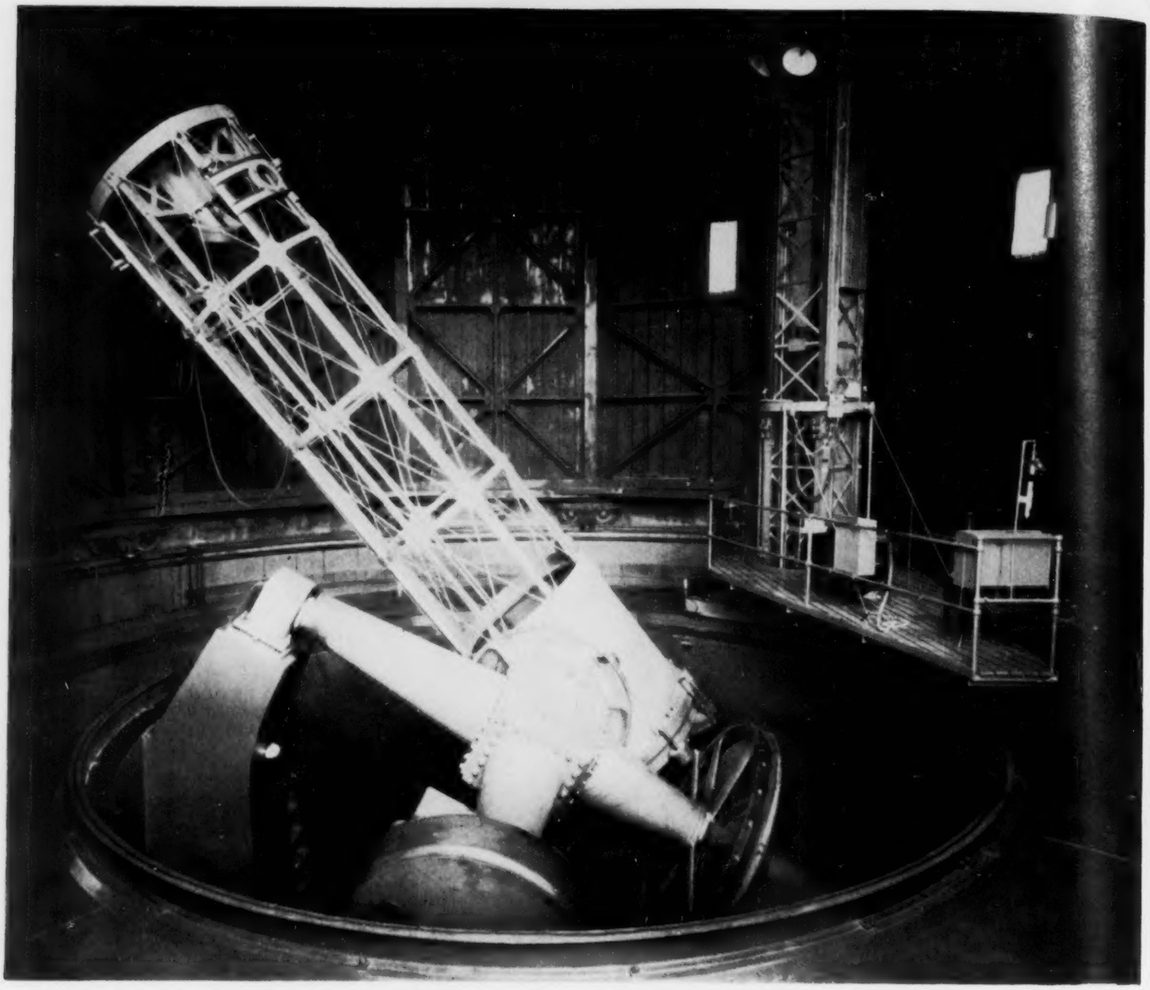
Zebras are at home at Lamont-Hussey. The 27-inch telescope is at the right; the prismatic camera with a 10.5-inch lens can be seen protuding from the camera house (left), which was completed in 1949. (University of Michigan photo.)



A contact print of the nebulosity surrounding Eta Carinae, taken with the ADH Baker-Schmidt telescope, by Bart J. Bok, under fair seeing conditions, one-hour exposure. (Harvard Observatory photograph.)



Boyden Station of Harvard Observatory, looking east.



The 60-inch Rockefeller reflector at Boyden Station, Bloemfontein, South Africa.

ones pulsate slowly. On this relation our measurements of the great distances to other galaxies depend, for they contain Cepheid variables too. The Magellanic Clouds have well been called the astronomer's tool houses.

Even for the nonprofessional astronomer the skies of the Southern Hemisphere offer attractions. The planet Mercury, which is usually visible only in the twilight for northern observers, is sometimes conspicuous for weeks at a time from below the equator, because the planet is situated somewhat south of the sun whenever it is farthest from the sun in the sky. And occasionally, as in 1947 and again in 1948, a very bright comet will appear that can be seen well only from the tropics and the Southern Hemisphere.

TO ARISTARCHUS

(THIRD CENTURY B. C.)

The laurel-wreathed Lycean School
Whose word was oracle,
Proved, in golden syllogisms,
That the earth lay motionless,
The center of a geocentric
Universe. You too
Had long observed (as they observed)
The day star rise
Over the rim of the Aegean, arch
The heavens, and curve low again
Beyond the mainland
West of Samothrace.
But this, for you, was less
Than certainty.
Some sharp necessity to penetrate
Beyond the eye's assurance,
Beyond the bright Aristotelian logic,
To the way things are,
Set you to drawing that small diagram:
The line from half moon
To the earth, and that acute
Revealing angle at the sun
That showed somewhat how distant
Was the solar radiance, somewhat
How great.
And then you knew it was the earth
Was satellite.

What a clean avoidance
Of the thought in fashion,
What a clear, right climate
Of the mind
Ripened such precocious truth
Two thousand years and more
Before its season!
Tonight I gaze where shadows fill
The crater that men named for you
Upon the moon,
Saluting your far, lunar cenotaph,
Oh Aristarchus!

GEMMA D'AURIA

Hollywood, California

Teaching, Research, Thinking

MILTON W. HOROWITZ

The author, who is an assistant professor of psychology at Queens College, New York, received his undergraduate training at the University of Connecticut, his master's degree from the University of Nebraska, and his doctorate at Stanford University (1947). During the war he was a research assistant in psychology with the National Defense Research Council. He taught at the University of Kansas from 1947 through 1950. His main interests are in social psychology (more specifically in social perception and interpersonal relations), personality theory, and methodology in science. He has published research in visual perception, motivation, and interpersonal relations.

I HAVE been thinking a great deal of late about the functions of teachers as they are manifested on the American scene. It occurred to me that it might be of benefit to others to trace the development of this thinking and of the conditions which lead to it, even though I cannot be sure what, if any, conclusions may result from this thinking. It may even seem naïve to the educator, for it has been done without benefit of formal instruction in education as a discipline. I am sure others have trod many of the same intellectual mazes that I have. Nevertheless, and perhaps precisely because of this naïveté, untrammeled by other modes of thought and untouched by the logic of previous solutions, it may be of greater benefit.

As teachers in American institutions, of various allegiances and in different disciplines, we are all aware in a marginal way of many of our difficulties, of the pressures surrounding us and impelling us into one or another educational venture, of our own great heritage and tradition, and of the forces that inhere in our work for positive good. It does not take a cultural anthropologist to tell us that, in some respects, modes or fashions in education are prescribed or fixed or perhaps only suggested by the prevailing moral, ethical, economic, political, or social mood of the dominant culture. In any case, forces exist to induce us to behave in acceptable cultural channels. Nor do we need an analysis of national character to impress upon us the fact that we are a materialistic nation in a period of our development that stresses strength and power in our inter- and intranational relations; that is characterized by loose moral scruples and ethical principles and values in our social, economic, political, and educational relationships. We live in an atmosphere and within a system that value the football coach more than the scholar. To use Matthew Arnold's comparison in a new context, America has become more Hebraic and less Hellenistic; we lay more stress on doing, on the importance of the *act*, and less stress on knowing. Whatever may be said of the latter, the former leads inevitably to narrowness and illiberality. And yet, only in a peripheral, semiconscious way do we realize how these facts affect us as teachers—in our theories and our doctrines, in our facts, in our principles, and in our living.

We do many things well. American colleges and universities give us excellent preparation for technical pursuits. We turn out good doctors and lawyers. Our engineers and our technicians of all sorts are excellent. Our architects are good. We glory in our "know-how," in our mechanical ability, in overt accomplishment. And, whether for good or evil, our educational institutions are turning out people, who, by training, *fit into* this cultural scheme. I believe, however, that we are doing less well other tasks that have been traditionally ours. Our citizen-graduates are considerably less than well-informed people. Our scholars (and I must admit that this is a controversial issue) are less than mature. Our theorists, thinkers, and system-builders are, for the most part, second-rate. I can speak competently only for my own profession, but is it not significant that the great majority of theory about the atom originated elsewhere but that American resources and technical ingenuity produced the first atomic bomb?

It may be symptomatic of the same cultural forces that businessmen and trained administrators run our colleges and universities. This is as it

should be to some extent, for schools *are* big business. They have tremendous physical plants; moreover, many of them have other assets, real estate, even spaghetti factories. There can be no question, too, but that large schools are political forces. The proper university can be the springboard to political duty for those who so aspire. More and more our presidents are schooled in business, industry, or even the Army, before they come to the academy. One sometimes suspects that a second degree is a handicap for those aspiring to a college presidency. I do not necessarily mean to imply that industrialists, politicians, or Army career men are bad men, or even that they make poor college presidents. However, the facts do imply a movement, a trend, or a tendency. They do imply that such men cannot be expected to know or understand the academic demands of colleges and universities—nor are they chosen with this in mind.

In my own profession, psychology, we look elsewhere for much of our theoretical guidance. In the clinic, in diagnosis, therapy, and personality theory, Freud, Adler, and Jung retain their stature. The masters have been revised and embellished but not significantly altered by us. More in other areas of psychology proper, Wertheimer, Köhler, Koffka, and Lewin wield tremendous influence. Of American theorists, system-builders, and developers, only Hull and Tolman (two contemporaries) come readily to mind; and it is interesting to note that Hull was greatly influenced by Woodger, the English biologist, in the development of his naturalistic system of learning and behavior, and Tolman came under many influences, not the least of which was Gestalt.

American psychology has pioneered and prospered with animal behavior, with statistical and quantitative elaborations, with intelligence tests, with paper-and-pencil personality tests. Our industrial, clinical, statistical, testing, and applied sections are flourishing. It is characteristic of us "to measure first and ask questions afterward." We can offer excellent intelligence scales, multiphasic scales of personality attributes, and an enormous interest in learning. It should not be surprising that *learning,* a part behavior, not central to the person, easily quantified and experimentally manipulated, is the dominant American psychology. Thinking, creativity, and other cognitive functions get comparatively little attention. Perception has only recently come into its own.

We have done much with the adjustment inventory—again not by chance, for adjustment is the symptom and outward manifestation of personality—but we have done little in the development of personality theory. Our psychology has tended toward the sensory, the outward, the applied, the quantitative. It is weighted with physiology, with neurology, with the observable, with the palpable. Is it not significant that American studies of motives started with tissue needs and ended with habits, which we call drives, but that Freud, a noted physiologist in his earlier scientific years, developed a psychological motivational system for which tissue needs were largely irrelevant? I do not think it would be unfair, or contrary to evidence, to say that we have obtained our theory and our thinking and the more vital elements of our psychological principles (and perhaps our wisdom) from abroad.

If I am correct in my summation, it is indeed an unfortunate state of affairs, but one which mirrors similar aspects in other disciplines as well as in other areas of our culture. We, the teachers, are traditionally academicians. We are traditionally the scholars and the thinkers (although "hard-headed" businessmen and industrialists have characterized us as idlers, dreamers, brain trusters, and more recently as "long-hairs"). It is probably no accident that a common household phrase is "It may be all right in theory, but . . ." How could thinking, theory, creativity, have fallen to such a low estate? And how have practicality, application, and action been divorced from theory and risen to such an eminence?

Of course we are all caught up in the same process. Perhaps we should examine America in the large, as an anthropologist might, for answers to our difficulties. I think we should, but I think also that it will not be inadequate if we begin with an analysis of what a college or university teacher does in America. Let us ask, what are the usual demands? What are the usual pursuits? What are teachers required to do? I believe that such an analysis will give us partial answers to the difficulties we face. The assumption here is that teachers in American colleges and universities, who are directly concerned with science (and education in general), are more or less unwilling links in a chain that starts with cultural demands, norms, and coercions, and ends with a scientific or educational product. We have examined the product above and found it not completely acceptable. Let us now examine what teachers are required to do for the clues this will furnish us as to why the product is unacceptable.

The Three Tasks of a Teacher

I believe that college or university teachers are required, or what is more important, believe that

they are required, to engage in three broad activities. We may label these teaching, research, and thinking.* It is natural to suspect that these activities are, or should be, coordinate. The day of the compleat man has long since passed, and it seems improbable that anyone would be required to perform three disparate tasks. Let us examine each in turn. After this examination we can discover, perhaps, what the three have in common.

The requirements of teachers. The main requirement of teachers is, of course, to teach. It is nevertheless a moot question to ask how much they should teach. It is a never-ending source of surprise to a layman to see a college professor wend his weary way home after his last class and seem exceedingly tired. A common belief is expressed in the incredulous exclamation: "Why you teach only fifteen hours a week—and you have a three-month vacation every summer!" It is appropriate to relate here the story of the state senator, member of a budget committee visiting the state university to ascertain conditions, who chanced upon a faculty member in the hall and engaged him in conversation.

"How many hours do you teach, professor?"

"I have a pretty light load this semester. I'm teaching eight hours."

Patting him paternalistically on the back, "Well, that's a good day's work."

It is difficult to know what a usual college load is. In New York city colleges it is fifteen hours by statute. At other institutions it varies—from school to school, from department to department, and from individual to individual within a department. It varies with upper-level (graduate) courses vs. lower-level (undergraduate) courses, with number of administrative duties, and sometimes with amount of committee work and thesis supervision. Many individuals carry deceptively light loads, for the balance is struck with administrative duties or committee work.

I do not wish to belabor the question of the amount of teaching we are required to do. I wish only to bring out the point that it is frequently too much to accomplish its only purpose—namely, to teach well. Teaching, like everything else, when taken in overdoses becomes a poison, and it will cause a slow intellectual death. Fortunately for us, by the time this occurs, our sensibilities have been dulled, and only the students suffer from the inexorable decomposition of our lecture material.

* It is tempting to add "living" as a fourth category. A little reflection, however, on the cost of living and college salaries quickly disposes of this as a requirement of teachers.

This is by no means the whole story of course. Few teachers can live well on their salaries. This is a well-known fact and needs no further documentation by me. What is less well known, however, is the extent to which teachers have left the profession to enter other, more lucrative, occupations; and, worse, how many teachers are forced to supplement their meager stipends with outside activities. Scratch a teacher and you'll find a Jack-of-intellectual trades—perhaps he has a small government or military or foundation grant from which he derives an extra sum; perhaps he hires himself out as an expert or a consultant for so much per hour or per day; perhaps he does extension or night teaching; most usually he must teach in the summer. Whatever it is, the remuneration, although necessary, is hardly payment for his maltreated larynx or the moral degradation he suffers from the realization that he cannot survive in his chosen profession without extra work.

Obviously, the solution here is to pay teachers enough so that they need do nothing other than teach; and, second, to reduce their loads to the point where they can teach well and be experts in the areas in which they do teach. A good teacher must be intellectually alive and unstultified. He needs time to prepare a course properly. He must decide on and choose its content and theory. He must think of examples to explicate his theory and know experiments which furnish data that support his theory or militate against it. He should have time to think about presentation. He must know about films and other visual aids that will assist him (and allot time to see the new ones). He must read and reread until he is thoroughly conversant with his special areas and able to coordinate them with other areas. He must keep up with the literature in the journals, which in itself can be a major activity. And he must understand and love his work so that some of his exuberance will bubble over and stimulate students to love it too.

The tasks listed here would keep a teacher busy full time if he could do them. Unfortunately, we have not yet exhausted the requirements of teachers. He has committee work. He goes to staff meetings, faculty council meetings, special committee meetings, student meetings, thesis committee meetings. Frequently he must take attendance in his classes. With other paper work, such as student records, posting of grades, sending in absence reports, and handling registration, it adds the last straw to the teacher's degradation. It is extraordinary that an institution will hire a scholar and a teacher and then force him to do clerical work that could be done more efficiently, more quickly,

and more accurately by a clerk at half the salary.

There are two main points that I wish to make. The first is that teaching, with no additional tasks, is itself a full-time job. The second is that its interests are broad and all-encompassing. The good teacher must be the scholar whose activities are ever-widening in terms of his interests.

The requirements of researchers. Let us inquire next into the requirements of research workers. It would not be surprising if we found little correspondence between the duties, or functions, or usual behaviors expected of the researcher and those expected of the teacher.

A hundred years ago, perhaps, we could have defined research to the satisfaction of most, but I fear that today it has too many facets and assumes too many shapes for us to do more than speak of it arbitrarily. There is industrial and applied research; there is library research; historical research; systematic research. Most certainly, however, to whatever kind of research one is devoted, its hallmark is narrowness. In contradistinction to the teacher, who must become as broad as possible, with his own chosen area as a base, the researcher becomes as narrow as possible, with his chosen area as a base. The researcher is the antithesis of the scholar. This is not to place an evaluation on the terms broad and narrow. It is simply a representation of the facts as I believe, for the most part, they exist. Psychology is a young discipline, but even so, few men can master more than one area within which they can do adequate and fruitful research.

Research, by its nature, is not an activity that accomplishes broad ends. Even in systematic research, where many able people work on segments or phases of one theoretical system, they accomplish narrow ends. Certainly any one individual can do little. And, fittingly enough, people are known for what they do. Someone does research on learning—and he spreads himself a little thin if he investigates conditioning, discrimination, adaptation, imitation, maze learning, and transfer. Perhaps one's main interest is concept formation. Someone else works on a phase of personality. Another has a specialized sensory area. By its nature, research cannot be broad. Indeed, the more we know, the narrower, the more sophisticated, the more esoteric, does research become. The more mature a science becomes the narrower does its research become.

A second requisite of research is that it requires time and patience. There is the initial thought about the problem, the weighing of issues—ideas are talked over with colleagues. Much reading on the problem at hand and consideration of other tentative solutions are necessary. Unlike scholarly reading, which tends to be leisurely, contemplative, and exhaustive, research reading tends to be none of these. Research is tricky and deceptive. In many of its aspects it is plain drudgery and dirt hard labor.† Naturally, it must be a labor of love, and perhaps this is the only common ground it shares with teaching. The usual mode of research is trial and error. Most research requires an explicit or an implicit dry run—a prior tryout to collect trial data or see how the apparatus, or the instructions, or the experimental setup works as a whole. Almost always there are corrections, reformulations, new instructions, simply by virtue of the fact that the practical demonstration of a hypothesis includes more variables that make a difference than the experimenter can know about.

A third function of research is that it requires technique. Much of modern research requires apparatus that the researcher must build. Most psychologists carry a screw driver or other tool almost as often as they carry a book. It is not uncommon for a psychological researcher to be a general handy man. He must know some carpentry and some machine work. Photography does not faze him. Mechanical appliances are his dish. The complete psychological researcher knows his elementary physics and some engineering principles—not infrequently he is a junior electronics expert.

A final factor affecting modern research is the pressure for publication. The number of journals and the number of articles have increased tremendously in recent years. Many institutions place considerable weight on number of publications as an index of maturity to proceed to the next higher rank. Quality of production is either secondary or is held to be unassessable. This adds, of course, to the feverish desire to get something into print. This is an attitude that is completely at variance with the leisure, the urbanity, and the scholarship necessary for the teacher.

Is it possible to be a good researcher *and* a good teacher? A tentative answer would be: Only to the extent that the activities of one are consonant with the activities of the other. It is common, but usually unspoken, knowledge that we regard our colleagues as one or the other. And, perhaps not oddly, the dichotomy is not a new one. Many are familiar with the names of Helmholtz and Kirchhoff. Both men have made singular research con-

† Someone has said that after you have conducted an experiment on your own you have so much more respect for others who do research and so much less confidence in their results.

tributions. Max Planck, who was a student of both, writes warmly of his experience with them:

. . . It was in Berlin that my scientific horizon widened considerably under the guidance of Herman von Helmholtz and Gustav Kirchhoff, whose pupils had every opportunity to follow their pioneering activities, known and watched all over the world. I must confess that the lectures of these men netted me no perceptible gain. It was obvious that Helmholtz never prepared his lectures properly. He spoke haltingly, and would interrupt his discourse to look for the necessary data in his small notebook; moreover, he repeatedly made mistakes in his calculations at the blackboard, and we had the unmistakable impression that the class bored him at least as much as it did us. Eventually, his classes became more and more deserted, and finally they were attended by only three students; I was one of the three, and my friend, the subsequent astronomer Rudolf Lehmann-Filhés, was another.

Kirchhoff was the very opposite. He would always deliver a carefully prepared lecture, with every phrase well balanced and in its proper place. Not a word too few, not one too many. But it would sound like a memorized text, dry and monotonous. We would admire him, but not what he was saying.[1]

It should not surprise us that most frequently the good researcher and the good teacher are not the same person. They have different goals, different interests, different problems. Probably, also, they have different traits, different temperaments, and different personalities.

The requirements of thinking. We have discussed teaching and we have discussed research, and have we not also discussed thinking? Teachers must think and researchers must think. But the thinking that teachers do is different from the thinking that researchers do, and the thinking of both these differs from the thinking I wish to talk about. As for research such as we have discussed, we can be categorical. When laboratory research begins, thinking stops. The thinking I wish to discuss is really a kind of creative thinking—it deals with large ideas, with systematic concepts and their relationships. It is theoretical in nature. It has nothing in common with research except insofar as it utilizes research results. It differs from the scholarly thinking of the teacher in having different goals—it is done for a different purpose and achieves different results.

In every discipline there exist persons whose essential work is not in research as we usually understand it, nor in teaching. They are systematizers, the unifiers. They attempt to make theoretical sense of data. There are physicists, for example—perhaps somewhat scorned by their hardier brethren—who either do not know how, or do not care how, to manipulate apparatus. They are not the dirty-hands physicists. They work with pencil and paper. There is a great need for such people. Moreover, such people have deep and central needs to do precisely what they are doing. They would wither and die in the competitive market place of researchers and would find the activities of the teacher alien to their main interests.

What are the requirements for people like this? One is freedom and lack of coercion. Every student will recall, perhaps, the exultation that came to him with each advance up the educational ladder. At least part of this came from the elimination of demands upon his time. As one progresses in his undergraduate curriculum, restrictions are loosened. It is no longer necessary to take 8 o'clock classes or required courses; perhaps even attendance is not required. In graduate school there are seminars and discussion groups rather than the usual lecture courses. One attends or does not attend, as he chooses. Reading is more leisurely and develops along the lines of main interest. Perhaps most important, examinations are frequently dispensed with.

Einstein tells us most cogently in his autobiographical notes how he passed up mathematics and chose physics as a profession. He saw how mathematics was split up into many separate specialties, each of which could take all of a man's life. A thinker, in contradistinction to a researcher, must spend his time on those things he regards as absolutely fundamental—on the forest, not on the trees.

True enough, physics also was divided into separate fields, each of which was capable of devouring a short lifetime of work without having satisfied the hunger for deeper knowledge. The mass of insufficiently connected experimental data was overwhelming here also. In this field, however, I soon learned to scent out that which was able to lead to fundamentals and to turn aside from everything else, from the multitude of things which clutter up the mind and divert it from the essential. The hitch in this was, of course, the fact that one had to cram all this stuff into one's mind for the examinations, whether one liked it or not. This coercion had such a deterring effect (upon me) that, after I had passed the final examination, I found the consideration of any scientific problems distasteful to me for an entire year. In justice I must add, moreover, that in Switzerland we had to suffer far less under such coercion, which smothers every truly scientific impulse, than is the case in many another locality. There were altogether only two examinations; aside from these, one could just about do as one pleased. This was especially the case if one had a friend, as did I, who attended the lectures regularly and who worked over their content conscientiously. This gave one freedom in the choice of pursuits until a few months before the examination, a freedom which I enjoyed to a great extent and have gladly taken into the bargain the bad conscience connected with it as by far the lesser evil. It is, in fact, nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curi-

osity of inquiry; for this delicate little plant, aside from stimulation, stands mainly in need of freedom; without that it goes to wrack and ruin without fail. It is a very grave mistake to think that the enjoyment of seeing and searching can be promoted by means of coercion and a sense of duty. To the contrary, I believe that it would be possible to rob even a healthy beast of prey of its voraciousness, if it were possible, with the aid of a whip, to force the beast to devour continuously, even when not hungry, especially if the food, handed out under such coercion, were to be selected accordingly. . . .[2]

Thinking, as I have spoken of it, requires an attitude that differs from that of the teacher and that of the researcher. It is tender and requires nurture. Helmholtz tells us that the suggestion of alcohol drove all creative thoughts from his mind —he got his most creative ideas while walking alone, quietly. It may have been Daniel Webster "whose most valuable thoughts came while jogging on his nag from place to place on his court circuit." Ideas cannot be forced to come. Excitement, rush, competition, busyness, drive them out completely. Always they demand the contemplative mood and the large view. Immediate results, of course, cannot ever be expected. It is an activity that is conceptual in nature and involves the use and manipulation of symbols and ideas.

What can we conclude from this very general and meager analysis of what teachers in America are required to do? It is my thesis, of course, that the three activities (teaching, research, thinking) are intimately related to the state of our science. In our society a teacher is expected to do all three. Somehow, these three regions of behavior, different from each other as they can be, by some peculiar cultural amalgamation have come to be expected from one person. Even this brief analysis will indicate that it is impossible to do more than one of them well. Teaching and research have been and are combined with varying degrees of success, usually, I should think, to the detriment of the former. At least when you teach badly, only your own conscience can bother you. If your research lags, your conscience, your status, and your pocketbook may be affected. Very likely it is impossible to combine successfully either teaching or research with thinking.

I do not mean that this amalgamation is the reason for any lag in producing scholars and thinkers. I think it is only related. Indeed, if we examine with honesty some of the implicit values and hidden assumptions of our culture I am sure that we can find many other cogent factors for our scientific sterility. For example, we place great value on memory, on facts, on knowledge for a purpose. And always with us is the emphasis on grades. We tend to stimulate learning not through intrinsic interest or desire for knowledge but through an external and irrelevant incentive. Try as I will, the image of the donkey with the carrot held just out of reach in front of it continually comes to mind.

The rigidity of the classroom, the compulsory attendance, the required courses, the omnipresent quiz and examination, all combine to stifle spontaneity and creativity and to drive the student along a prescribed path that someone else considers desirable. It is no etymological accident that students frequently refer to their college as the factory, for in many respects our educational system is of the assembly-line, canned variety.

I am not sure what to propose to correct these conditions. Most certainly our illness resides to a great extent in our culture, and it would help little to change our curricula, change our standards, change our teaching methods or even, as Hauser[3] suggests, to impart to our students a grounding in basic philosophical principles and an understanding of clear and logical thinking. For as long as the illness is in the culture, we cannot cure it by attacking its symptoms in the educational system. Perhaps our salvation lies in changing the culture. Unfortunately, history teaches that cultures change slowly even when pushed.

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Svalbard: Norway's Arctic Frontier

LAWRENCE M. SOMMERS

Dr. Sommers' article is based on research begun in Norway in 1948, where he worked under a fellowship jointly sponsored by the American Scandinavian Foundation and the Social Science Research Council. In 1949 he joined the Department of Geology and Geography at Michigan State College, where he is now assistant professor of geography. He took his Ph.D. at Northwestern University in the summer of 1950. At present he is engaged in additional research on the geography of Norway.

THE East-West "cold war" has brought into recent international focus the remote group of Norwegian islands called Svalbard* (Fig. 1). The strategic arctic location of these islands and their valuable coal deposits are items of concern to many countries. Svalbard was placed under Norwegian sovereignty by the Paris peace treaty of 1920. According to this treaty, however, the subjects of the signatory powers enjoy the same rights in Svalbard as Norwegians.† At present the Soviet Union is the only nation taking advantage of these rights, and in fact the present Russian population on Svalbard actually outnumbers the Norwegian. Russians comprised 68 per cent of the 3587 persons spending the winter of 1949–50 on the islands.[1] In addition to active coal exploitation, Soviet interest in the area is evidenced by several unsuccessful attempts to sign a joint defense pact with Norway. Bases on Svalbard would lessen the arctic air route distance between Sverdlovsk in the Ural Mountains and Chicago, for example, by one fourth.

Location and size. Svalbard includes all the land situated in the Arctic Ocean between 10° and 35° E longitude and between 74° and 81° N latitude (Fig. 1). The island group has a central location between Norway and the North Pole and between the Soviet islands of Franz Josef Land and the Danish island of Greenland. Sörkapp ('South Cape'), the southern tip of the island of Vest ('West') Spitsbergen, is about 425 miles north of Hammerfest, Norway.

The islands cover a total land area of 24,095 square miles. This is nearly one fifth the size of Norway and about the same size as the state of West Virginia. Vest Spitsbergen is by far the largest island of the group, with an area of 15,250 square miles (Fig. 2). Nordaustlandet ('Northeast Land'), with an area of 5800 square miles, is next in size, followed by Edgeöya ('Edge Island') and Barentsöya ('Barents Island'). There are many smaller islands, including Björnöya ('Bear Island'), which is located about 150 miles south of Sörkapp and 250 miles north of Norway (Fig. 1).

Population. Nearly all the 3587 inhabitants of Svalbard in 1949 were located on the island of Vest Spitsbergen (Table 1). Most of the 1149 Norwegians lived in the two coal mining settlements of Longyearbyen and Ny-Aalesund (Fig. 2); the 2438 Russians, in the three mining settlements of Barentsburg, Grumantbyen, and Pyramiden. A few Norwegian radio and weather technicians were located at isolated points such as K. Linné, Hopen, and Björnöya. Hunters of arctic fur animals occasionally inhabit some of the islands, but most of the population, both Norwegian and Russian, consists of coal miners. None of the inhabitants are indigenous to the islands.

The natural environment. Svalbard is predominantly a high mountainous and dissected plateau country. The average elevation of Vest Spitsbergen is approximately 2000 feet, but a few mountain peaks reach 3000 feet or more. The highest peak,

* The Norwegians changed the name Spitsbergen back to the old name Svalbard when they took formal possession in 1925.

† The signatory powers include the United States, Denmark, France, Italy, Japan, Netherlands, Great Britain and Ireland, Dominion of Canada, Dominion of New Zealand, Union of South Africa, India, Sweden, Soviet Union (1924), and Germany (1925). The treaty was later signed by other nations.

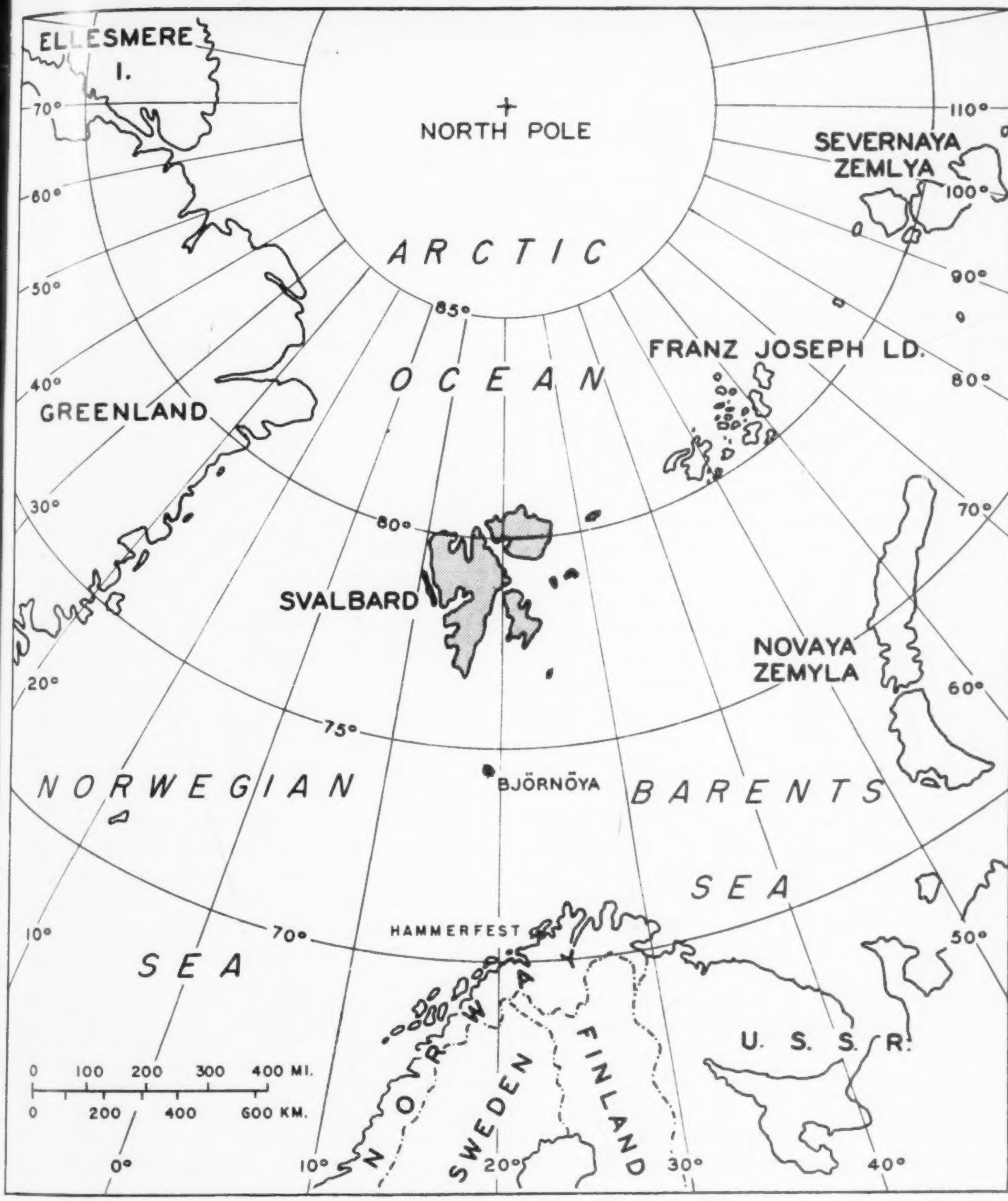

Figure 1.

Newtontoppen, is 5630 feet above sea level (Fig. 2). Björnöya has the least relief of the island group, with a high point of only 1757 feet.

Approximately two thirds of the surface of the islands consists of permanent snow and ice fields (Fig. 2). The ice cover is more complete in the colder and higher eastern portions of the islands, and in eastern Nordaustlandet, the glacier ends in ice walls 150–300 feet thick which obliterate the shore line. Glaciation has resulted in an extremely fjorded coast line similar to that of Norway. Several fjords, such as Isfjorden, extend far inland.

The North Atlantic Drift moderates Svalbard's climate despite the high latitude. This warm drift, bathing the west and north coasts, keeps the water open to summer navigation farther north than any-

where else on the globe. Despite this moderating influence, the climate is rigorous and variable. At Green Harbour on Isfjorden there is an average of only 64 frost-free days (Fig. 3). At this same station the yearly temperature averages 18.3° F, with an absolute maximum temperature of 60.4° F and an absolute minimum of −56.6° F. The mean average for the warmest month (July) is 41.7° F and for the coldest month (February) is −2.4° F. The average precipitation of 11.8 inches is well distributed throughout the entire year, with slightly greater amounts falling during the winter months.

The severe climate and short growing season result in a sparse vegetative cover, which varies considerably; the most common types are dwarf birches, lichens, mosses, and creeping willows. Animals are also scarce. Polar bear, polar fox, and reindeer were the original land animals. The musk ox, imported from East Greenland in 1929, has been successfully established, but the arctic hare, also imported, has not fared as well. Some seals, walrus, and small whales are found off the islands.

Historical development. Although coal mining by the Russians and Norwegians dominates the present activity on Svalbard, other resources and other nationalities have been of intermittent importance since rediscovery of the islands in 1596 by a Dutch expedition.‡ This expedition, headed by Willem Barents, was searching for a short route to East Asia. In the years following, the rich whaling grounds drew many explorers. Competition for the land resulted, with the English, Dutch, Germans, Danish, and Norwegians obtaining holdings. The Dutch erected a whale-processing settlement on the coast of Vest Spitsbergen that is said to have numbered 2000 inhabitants during the summer season. Whale hunting declined about the middle of the seventeenth century, and the islands were nearly forgotten for the next half-century.

From about 1700 to the middle of the nineteenth century Russia was the most active nation on Svalbard. Russians spent the winters hunting polar bears, seals, reindeer, foxes, and walruses for their furs. In the early part of the eighteenth century Norwegian hunters visited the major island of Vest Spitsbergen, and later Norwegian sealing expeditions frequented Svalbard waters. From 1852 to 1919 Norway was able to exploit the islands without Russian competition.[2] The Norwegians began small-scale exploitation of Svalbard coal in the 1890s, and soon several other nations

‡ According to the Icelandic Annals, the islands were first discovered by Norsemen from Iceland in 1149.

TABLE 1

WINTER POPULATION OF SVALBARD SETTLEMENTS*

Location	Number of Persons 1946–47	1947–48	1948–49	1949–50
Norwegian				
Longyearbyen	589	828	890	984
Sveagruva	198	284	310	2
Ny-Aalesund	162	221	234	129
Hopen	—	4	4	4
Björnöya	—	3	3	4
Svalbard Radio Station	—	6	6	7
Isfjord Radio Station	—	3	4	4
Other persons (location not given) †	—	22	8	15
Norwegian total	1076	1371	1459	1149
Russian				
Barentsburg	—	500‡	600‡	1180
Grumantbyen	—	200‡	350‡	965
Pyramiden	—	500‡	600‡	293
Russian total	600	1200‡	1550‡	2438
Svalbard total	1676	2571‡	3009‡	3587§

* Source: *Norges Bergverksdrift 1946–1949,* Statistisk Sentralbyraa, Oslo.
† Includes 2 hunters, 10 government officials, and 3 clergymen.
‡ Estimates.
§ Includes 60 Norwegian and 51 Russian children.

evidenced interest in this development, including the United States, Sweden, Netherlands, and the Soviet Union. The industry did not become really important, however, until after the end of World War I (Fig. 4).

The Paris peace treaty following World War I awarded Norway sovereignty of Svalbard because of her whaling, hunting, and mining interests and her great need for coal.[3] Prior to the treaty, land and other interests in Svalbard were claimed by citizens of Norway, the United States, Great Britain, Sweden, Netherlands, Germany, and the Soviet Union. A Svalbard Commissioner was appointed by the treaty nations to dispose of these claims. He officially recognized 17 claims involving 40 properties and covering a total area of 4225.3 square kilometers. Some of these properties have since been transferred to other owners. In 1950, 32 of the 40 treaty properties were Norwegian, 4 British, and 4 Russian. Expressed in terms of the total area involved, 87 per cent was Norwegian, 7 per cent British, and 6 per cent Russian.[4] Thus the international character of Svalbard is apparent.

Coal mining. Nearly 600,000 metric tons of coal were mined on Svalbard in 1949 by Norwegian and Russian companies. Approximately four fifths of this total was shipped to Norway (Table 2). This coal resource is of great strategic importance to Norway, as it annually supplies about one third

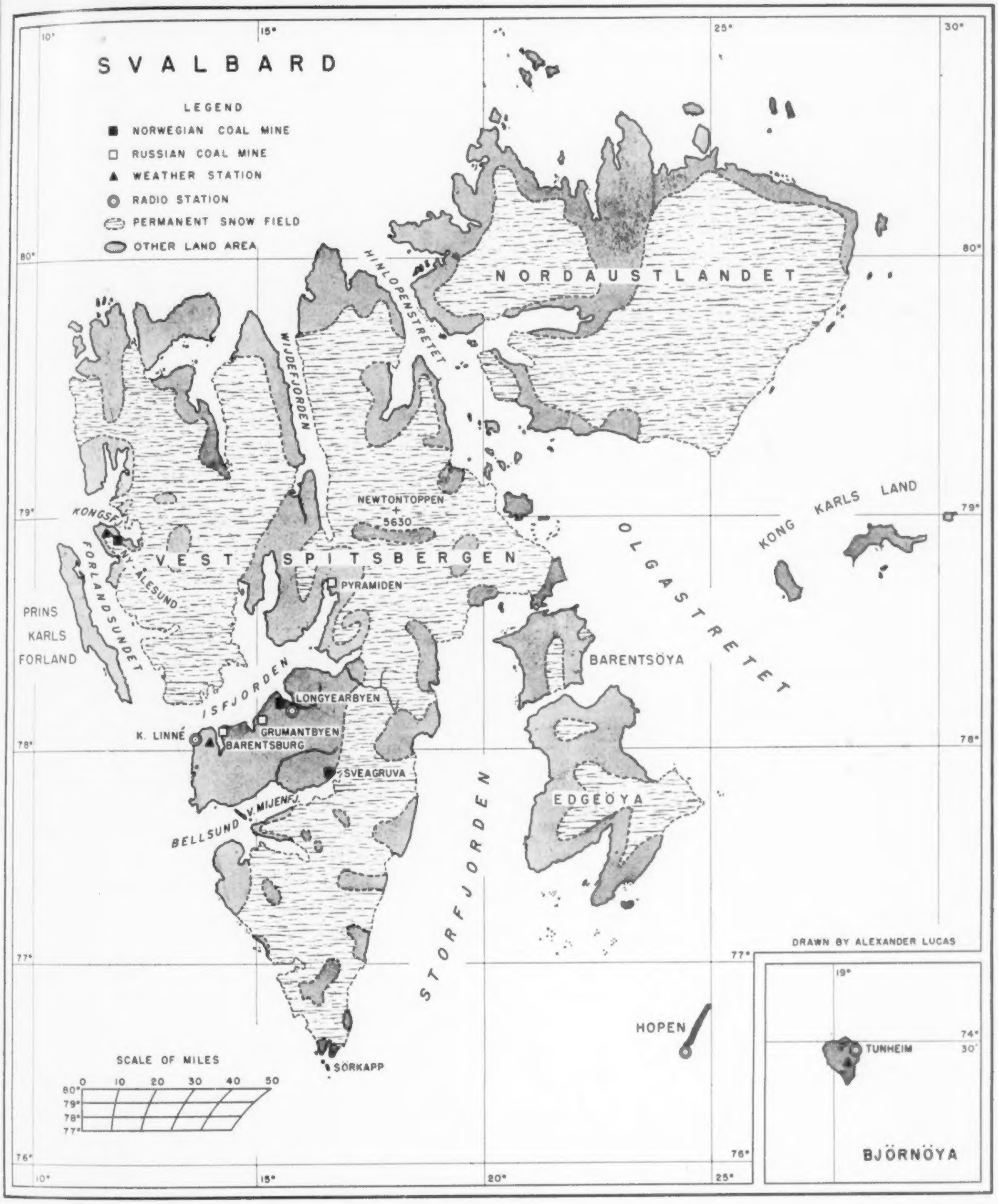

Figure 2.

of her coal needs. Although Svalbard coal was discovered and used by whalers in the seventeenth century, it was not until the present century that it has been systematically mined. An American company headed by a man named Longyear started mining operations in 1906 near the settlement that still bears his name—Longyearbyen (Fig. 2). World War I forced the Americans to cease operations, and in 1916 they sold their coal fields to a Norwegian company—Store Norske Kullkompanie A/S. A Swedish company that began mining near Sveagruva in 1917 also sold out to the Norwegian company in 1933. The Russians began operations by purchasing the Barentsburg colliery,

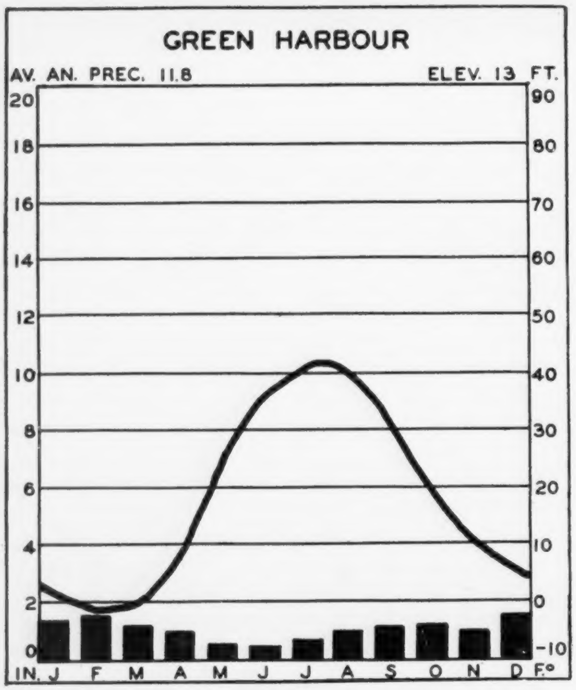

FIGURE 3. Climate graph for Green Harbour weather station located near K. Linné on Vest Spitsbergen.

which was started in 1912 by a Norwegian company, was sold to the Dutch in 1920, and resold to the Russians in 1932. In 1949 there were three Norwegian and three Russian mines operating on Svalbard.

Known coal formations exist on the islands of Vest Spitsbergen and Björnöya. Vest Spitsbergen has coal of Carboniferous, Jurassic, and Tertiary geologic age, and that on Björnöya is of Devonian age. Norway began mining coal on Björnöya in 1915 to aid her desperate coal situation which developed during World War I. Large financial losses resulting from the poor quality of the coal and inadequate harbor facilities forced discontinuance of these operations in 1925 (Fig. 4). Estimates place the Björnöya coal reserve at approximately 200,000,000 tons.[5]

The largest quantities of coal on Vest Spitsbergen are of Carboniferous age. Except in one Russian mine, however, mining occurs in the more accessible Tertiary formations. A hard, good quality bituminous coal is produced, which is contrary to the fact that coal of Tertiary age is generally brown and of poor quality. Most of the coal seams mined at present are quite thick, nearly horizontal, and outcrop on the side of the fjords or fjord valleys, making possible the use of drifts rather than deep shafts. The frozen formations lessen the necessity for pit props and in most areas eliminate the problem of water accumulation in the mines. Although fresh air is usually easily available, gas does accumulate in some of the mines and explosions occur.§ Other disadvantages include the short navigation season and rather rigorous working and living conditions.

After a four-year lapse during World War II, the Norwegian coal companies returned to Svalbard in 1945 to repair the war damage and resume limited mining (Fig. 4). The Germans burned most of the mining and shipping installations, as well as many other buildings, in 1943. In the initial postwar years many of the employees were engaged in reconstruction activities rather than in mining. The Norwegian production was only 6000 metric tons in 1945, but by 1949 totaled over 450,000 metric tons, nearly equal to the prewar level (Table 2). The active Norwegian mines in 1949 were located at Longyearbyen on Isfjorden, Sveagruva on Van Mijenfjorden, and Ny-Aalesund on Kongsjforden (Fig. 2). The Longyearbyen and Sveagruva mines are operated by the Store Norske Spitsbergen Kullkompanie A/S, and those at Ny-Aalesund by Kings Bay Kullkompanie A/S.

Longyearbyen. About 80 per cent of the 456,542 metric tons of coal mined by Norwegians in 1949 came from the Longyearbyen mines. This coal is of high quality and occurs in nearly horizontal layers. It is easily accessible by the drift mining method, as it outcrops on a hillside. With modern mechanized equipment each worker mines nearly 3 tons of coal per day, an average greater than elsewhere in Europe.[6] Three shifts of workers are employed, each working eight hours. The coal is carried by a conveyor system from the mines down to the washing, cleaning, and storage areas near the docks.

§ Forty-four persons have been killed in mining accidents in Svalbard since October 1948. The latest explosions, in January 1952, killed 6 at Longyearbyen and 9 at Ny-Aalesund.

TABLE 2

SVALBARD COAL PRODUCTION AND SHIPMENT, 1949*

MINING AREAS	PRODUCTION (Metric Tons)	SHIPMENT (Metric Tons)
Norwegian		
Longyearbyen	368,775	329,877
Sveagruva	63,445	80,353
Ny-Aalesund	24,322	15,637
Norwegian total	456,542	425,867
Russian	125,000†	105,446
Grand total	580,000	531,313

* Source: *Norges Bergverksdrift 1949,* Statistisk Sentralbyraa. Oslo: H. Aschehoug & Co., 47 (1951).

† Approximate total from Grumantbyen, Barentsburg, and Pyramiden.

About 330,000 metric tons of coal were shipped from Longyearbyen in 1949. During the short shipping season, which normally lasts from mid-May to early November, a feverish pace is set to make the most of the time available. Ships can be loaded by a conveyor belt system at the rate of 400 tons per hour. A stock of 200,000 tons of coal may accumulate from mining during the winter.

The miners live in barracks, eat in a common mess hall, and have access to a community center, completed in the fall of 1951, which provides entertainment, library, gymnasium, and religious facilities. The administrative staff and their families live in individual housing units. The settlement at Longyearbyen, numbering nearly 1000 inhabitants, contains most of the Norwegians on Svalbard.

Sveagruva. The mines at Sveagruva, opened by the Swedes in 1911, were taken over by the Store Norske Spitsbergen Kullkompanie A/S in 1933. The installations burned down by the Germans in August 1944 have been rebuilt. The annual postwar output was nearly 100,000 tons of high quality Tertiary coal. Mining at Sveagruva was suspended in 1949 because of the difficulty in procuring the necessary water-pumping equipment, as well as the difficulty of disposing of the coal in Norway. The Norwegian coal consumption is only one half the prewar level and at present limits the amount of Svalbard coal that can be sold in Norway to about 400,000 tons.[7] Many Norwegian factories and railways have converted to electric power, and the rebuilt merchant marine burns mostly oil. The Norwegian company decided to concentrate efforts temporarily on its Longyearbyen holdings. Thus all Sveagruva personnel except for two watchmen were transferred to Longyearbyen by October 1949. It seems probable that because of the excellent quality coal, however, the Sveagruva mines will soon be reopened.[8]

The Sveagruva shipping season is shorter than that of other Svalbard mines. The date of the first spring shipments is delayed by an island that nearly closes the mouth of Van Mijenfjord and prevents the winter ice from drifting out to sea. Shallow water also makes navigation dangerous in the fjord for large ships. The 1949 shipments from Sveagruva totaled 80,000 metric tons.

Ny-Aalesund. The northernmost colliery in the world was started at Ny-Aalesund by Kings Bay Kullkompanie A/S in 1916. The coal is of Tertiary age but has a higher hydrocarbon content than Longyearbyen and Sveagruva coal. Although the coal is of high quality, exploitation is difficult and costly because of the inaccessibility of coal formations, faulting, and accumulation of gas in the

FIGURE 4.

mines. Mining ceased in 1929 and was not resumed until after World War II. This area suffered only minor damage during the war. A total of 129 Norwegians, mostly miners, spent the winter of 1949–50 at Ny-Aalesund (Table 1). Coal production was hampered in 1949 by a destructive explosion in 1948.

The transportation of the coal from the mine to the loading docks is facilitated by a small railway, the most northerly in the world. A large cleaning and sorting plant was constructed near the docks in 1950. The shipping season from Ny-Aalesund is lengthened by the warm waters of the North Atlantic Drift, and during some winters Kongsfjord does not freeze. The 1949 shipments totaled approximately 15,000 tons of the 24,000 tons produced.

A major reason for the decision of the Versailles treaty powers to award sovereignty of Svalbard to Norway was her great need of coal. The importance this coal now plays in Norway's economy is shown by the fact that 408,000 tons, approximately 29 per cent of her 1949 coal imports, came from Svalbard (Table 3). Most of the coal is utilized in northern Norway, but some is shipped direct to Oslo for use by the Norwegian State Railways in southern Norway.[9] In 1951 the Norwegian

collieries hoped to achieve the shipping goal of 470,000 tons before the ports became ice-locked.[10] Thirteen freighters were engaged in carrying coal from Norway's arctic province during the summer of 1951.

TABLE 3

LEADING SOURCES OF NORWAY'S COAL IMPORTS—1949*
(Excludes Coke)

SOURCE	AMOUNT (Metric Tons)	VALUE (KRONER)
Poland	623,480	58,846,768
Svalbard	407,873	37,551,773
Great Britain and North Ireland	327,968	32,647,914
Germany (British and American Zones)	26,049	2,703,346
Germany (Soviet Zone)	9,458	713,914
USSR	953	134,016
Total	1,406,895	132,614,354

* Source: *Norges Handel 1949,* Statistisk Sentralbyraa. Oslo: H. Aschehoug, 133 (1951).

Russian mines. Though the Paris treaty gives the Russians the right to exploit the coal resources of Svalbard, the mines are subject to Norwegian sovereignty. At present the Russians are mining coal in three places on Isfjorden (Fig. 2). Grumantbyen, the oldest Russian mine, was opened in 1919. As mentioned before, their second colliery, located at Barentsburg, was purchased from the Dutch in 1932. The Pyramiden mine, opened just prior to World War II, soon became the largest of the three. However, the mining of Carboniferous age coal at Pyramiden thus far has not proved successful, and activity at Pyramiden in 1949 was limited to small-scale mining operations and further exploratory work. The Russian production of 125,000 metric tons in 1949 came mainly from the Tertiary coals of Grumantbyen and Barentsburg. Production figures for individual mines are not available.

All the Russian mines are owned and operated by a government company called Arktikugol. Russia must pay Norway a royalty on each ton of coal mined, and in addition, each Russian national living on Spitsbergen must pay a personal tax to the Svalbard administration. A Russian consul is stationed at Pyramiden, and relations between the Russians and Norwegians on the island are friendly.[11]

The Russians returned to Svalbard in November 1946 with 600 personnel to reconstruct their three mining areas (Table 1).‖ The number of postwar employees grew steadily and by 1949 numbered 2438. Many of these men have been employed in rebuilding war-destroyed mining installations and dwelling units. The number employed in each of the three mining areas varies considerably. In 1949 most of the Pyramiden personnel were shifted back to Grumantbyen and Barentsburg (Table 1).

‖ Both the Russians and the Norwegians were evacuated from Svalbard in 1941.

In 1949 the Russians shipped about 105,000 tons of coal, approximately one fifth of the total shipped that year from Svalbard. Poor harbor facilities at Grumantbyen necessitate the use of small "lighter" vessels to carry coal out to a larger vessel anchored in deep water, but better harbor facilities exist at Barentsburg and Pyramiden. The Norwegian government has built navigation lights serving the Russian communities, and a small Russian icebreaker aids in keeping the water connections between their settlements open through December. Navigation is also facilitated by a Russian-operated wireless radio station.

Other activities on Svalbard. Very few people inhabit Svalbard other than those living in the coal-mining settlements. In 1949, 18 Norwegians were operating weather and radio stations; 11 were located on Vest Spitsbergen, 3 on Björnöya, and 4 on Hopen (Fig. 2). Weather reports, sent several times daily from these stations, are of great value to weather forecasters in Norway and other north European areas. The weather and wireless stations, along with navigation lights, aid arctic ship and air traffic in the vicinity of Svalbard.

Normally about 30 Norwegians spend the winter on Vest Spitsbergen hunting blue and white polar fox and polar bear. Low fur prices reduced the number to 2 in 1948–49.[12] The hunters and trappers get rights to certain districts for their operations. Some Norwegians are engaged in hunting whales in the waters off the islands. Despite the decline in the number and importance of whales in arctic waters, 697 "small" whales were harpooned in the Svalbard area in 1948.[13] This represented about one fifth of the total number of whales harpooned by Norwegian hunters both in waters near Norway and in the Arctic Ocean. Sealing on ice floes near Svalbard is of little present importance.

Fishing for cod and halibut takes place on the banks around Björnöya and off the west coast of Vest Spitsbergen. Most of the catch (predominantly cod) is obtained near Björnöya. In 1948, 45 Norwegian fishing vessels equipped with long lines were operating in Björnöya and Vest Spitsbergen waters.[14] A few large trawlers operate in the area during the summer months and deliver fresh halibut and salted cod to Norway. A fishing station where ships could buy salt and receive necessary

supplies was established at Ny-Aalesund in 1935, but was closed in 1939. Periodic changes in the numbers of cod, probably as a result of varying oceanographic conditions, cause shifts in the importance of these fishing banks. A low cycle in the number of cod exists at present. Some fishing also takes place eastward toward Novaya Zemlya.

Besides coal several minerals, such as gypsum, asbestos, and iron ore, are found on Svalbard. Gypsum has been commercially mined by the Norwegians, but in 1939 the work was temporarily suspended.[15] Though no commercial timber is found on the islands, ocean currents carry some timber across the Polar Basin from the Soviet shores. This driftwood is collected and used for houses, pit props, and repair work.

The future. Present trends and anticipated future developments indicate that the economic and strategic importance of Svalbard to Norway will increase. Norway's self-sufficiency in coal can be increased by expanded utilization of Svalbard production. One step in this direction is the present construction of plants in Trondheim and Bergen for making briquettes from Svalbard coal. Another is the experimentation by Norsk Hydro and Store Norske Spitsbergen Kullkompanie A/S to find a method of utilizing coal in petroleum production. If successful this industry alone may use 1,500,000 tons of Svalbard coal per year.[16] If methods of producing coke from various types of bituminous coal being tested in the United States are feasible and economical, Norway may be able to meet future domestic needs for coke by processing coal from Svalbard. Foreign markets for some Svalbard coal may develop as the sale of 50,000 tons to Sweden in 1950 indicates. Thus there appears to be a promising future for Svalbard coal.

Though coal dominates the present economic importance of Svalbard, deposits of other minerals such as iron, gypsum, and asbestos have been discovered and represent potentialities for future exploitation. Further geologic exploration may reveal still others. The many unknowns of Svalbard present an outlet and a challenge to the Norwegian pioneering and exploring spirit.

The maintenance of arctic weather and radio stations to facilitate weather prediction in Norway and other northern European areas will be of continued significance. They perform an invaluable service to ship and air navigation in the adjacent areas. Tourism is another important potentiality for Svalbard. As facilities on Vest Spitsbergen, and tourist ships, become available, it is likely that a considerable number of curious tourists will be attracted by the area's arctic charm.

International concern over Svalbard is likely to continue. The location of these islands in relation to any present or potential arctic commercial or military air route makes them of strategic importance. In the event of World War III, they would be valuable naval or air bases for either the Russians or the Atlantic Pact nations, although the 1920 treaty prohibits the construction of such bases by any power. Nevertheless, the availability of long-distance sea, and especially air, transportation changes Svalbard's previously remote location to a potential arctic mainline station of considerable global significance.

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The National Physical Laboratory*

This paper, relating the origins, history, and work of the National Physical Laboratory, was written by a member of its staff. The laboratory is the United Kingdom's counterpart of the National Bureau of Standards, featured last September in The Scientific Monthly. *In accordance with the usual practice of the British government, articles that are prepared officially bear no signature.*

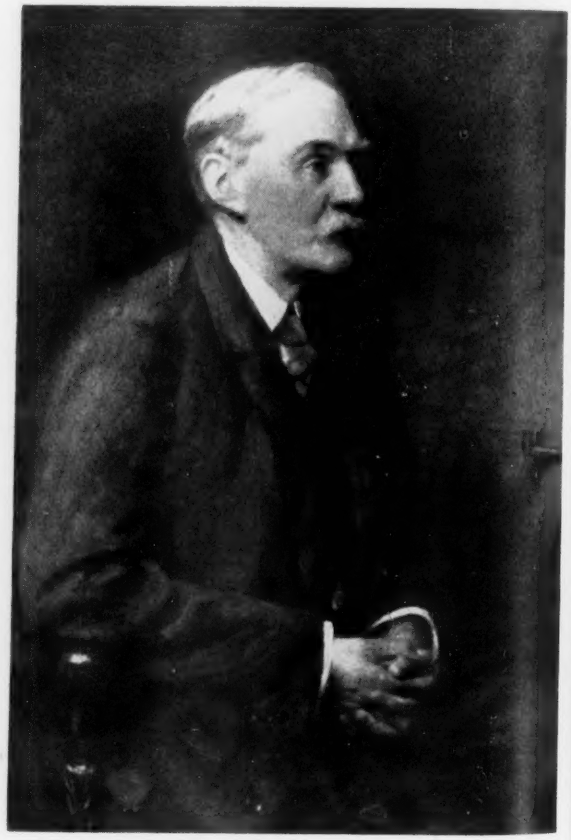
THE National Physical Laboratory at Teddington, a few miles out of London, is a year older than the National Bureau of Standards in Washington, D. C., and celebrated its fiftieth anniversary on January 1, 1950. The present director, E. C. Bullard, took up his duties on that day, exactly fifty years after the late Sir Richard Glazebrook assumed office as the first director.

The Royal Society, which was founded in 1660 under the patronage of King Charles II and which is one of the oldest and probably the best known of all the learned societies, has always been closely responsible for the scientific work of the laboratory, and the immediate celebration of the jubilee was a reception in the society's rooms in Burlington House, Piccadilly, London. Wider recognition of the occasion came, however, in the early summer of 1951, as part of the Festival of Britain. On May 21 and 22, an international symposium was held at the laboratory on "Recent Developments and Techniques in the Maintenance of Standards." Fourteen national standardizing laboratories and about sixty research establishments and industrial firms from Great Britain and overseas sent representatives; B. L. Wilson, chief of the Engineering Mechanics Section of the National Bureau of Standards, gave the first paper of the symposium, at the session on "The Primary Load Standard."

The meetings were followed by four Open Days during which nearly 4000 people inspected the work of the laboratory and attended short lectures on various items of the research in progress. As the visitors walked or drove about the laboratory grounds, which now cover more than sixty acres, very few of them can have realized or remembered from what small beginnings the NPL has grown.

By the end of the nineteenth century, the Physikalisch-Technische Reichsanstalt, founded at Charlottenburg in 1887, was already a powerful force for scientific and industrial progress in Germany. Industry in that country was expanding out of all recognition, and the cause clearly was the realization of the importance of scientific research and of the immediate practical application of the results. No institution of comparable scope and status existed in Britain, and by the 1890s British scientists and industrialists were urging the necessity for such a foundation.

In 1891, Sir Oliver Lodge, a physicist famous for his studies in electricity and wireless telegraphy,



The late Sir Richard Glazebrook, first director of the National Physical Laboratory.

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who was later to become the first principal of Birmingham University, made a vigorous plea for the inauguration of a

> Physical Observatory . . . aiming at the very highest quantitative work in all departments of physical science . . . accuracy should be the one great end. The Laboratory will also be the natural custodian of our standards, in a state fit for use and for comparison with copies sent to be certified. Else perhaps someday our standard ohm may be buried in a brick wall at Westminster, and no one living may be able to recall precisely where it is.

The Royal Society and the British Association for the Advancement of Science took up the question with the government, and in 1895 a committee was set up to consider the establishment of a National Physical Laboratory for the more accurate determination of physical constants and for other quantitative research. In 1897, Lord Lister, world-famous surgeon known as the founder of antiseptic surgery, headed a deputation to the Prime Minister, Lord Salisbury. A committe subsequently formed under Lord Rayleigh visited the Reichsanstalt and other German institutions and considered the coordination of standardizing work in England. Rayleigh, one of the most famous of all English physicists and a man of wide scientific interests and achievements, was the ideal person to lead such a committee. The Committee showed the government and the country as a whole that in every department of standardization British facilities were either inadequate or nonexistent. For example, users of British steel, one of the country's most important products, commonly demanded that it be tested and stamped at the Reichsanstalt.

Eventually the constitution of the new laboratory was settled, and funds were made available: the Royal Society would control the work of the establishment and would appoint a governing body, and the government would ask Parliament for £4000 a year for five years and £12,000 for building. (The meagerness of these first resources is shown by the fact that the National Bureau of Standards, founded soon after, was granted an annual sum equivalent to £19,000 and the equivalent of £115,000 for building.) This tiny income meant that the new laboratory had to help to pay its way, and about one third its present annual expenditure of £800,000 is still recovered in fees for tests and investigations.

In 1899, the first Executive Committee was appointed, with Lord Rayleigh as chairman. It included Lord Lister, Sir Oliver Lodge, Sir Andrew Noble (an expert in ballistics), Sir Arthur Schuster (a spectroscopist, at that time professor of physics at Manchester University), Alexander Siemens, who was the first engineer to install a system of electric lighting in a British town (at Godalming in Surrey), and Sir J. J. Thomson, who had succeeded Rayleigh as Cavendish professor at Cambridge in 1884 and was largely responsible for making Cambridge an international center for advanced physics.

Under the laboratory's constitution the president, treasurer, and a secretary of the Royal Society were always to be members of the Executive Committee, together with the permanent secretary of the Board of Trade and representatives of certain technical societies—the Institutions of Civil, Mechanical, and Electrical Engineers, the Iron and Steel Institute, the Society of Chemical Industry, and the Institution of Naval Architects. The committee appointed Richard Glazebrook as the first director, and Queen Victoria made available Bushy House, a royal residence near Hampton Court, to be the first of the laboratory's buildings.

Bushy House, which is still both a laboratory and the residence of the director, was built in 1708, and improvements were made toward the end of the century by the Duke of Clarence (afterwards King William IV), who lived there for many years, first with Mrs. Jordan, the actress, and their family of ten children, and later with his Queen, Adelaide. The Queen was extremely fond of Bushy House and retired to it altogether after her husband's death in 1837. The neoclassical "temple" in which George IV placed the mainmast of the *Victory* after the death of Nelson is still standing in the garden under the ancient beeches. It is said to have been designed by Christopher Wren.

As country houses go, the house is fairly small and unpretentious, but of elegant proportions; it still looks, in fact, what it was built to be, a charming and comfortable home. From the director's drawing room, his guests look across a bright garden to the temple and the trees of Bushy Park; the numerous laboratory buildings, various in size and some of them bizarre in appearance, are hidden behind the garden wall.

In this old house in 1900, Glazebrook began with a handful of poorly paid enthusiasts to carry out the dozens of urgent tasks that waited on the new laboratory. It is said that he could often be found wandering through the rooms at midnight, suggesting to members of his staff who were still at work that it was nearly time for bed. The long hours and poor pay were in themselves assurance that only the keenest workers would be attracted to the place. One engineer, now retired, recalls that Dr. Glazebrook engaged him as a junior on the scientific staff in June 1909, at a salary of £110 a year

Bushy House—the southern aspect.

(about $440 at that time), with an annual increase of £7 10*s*., "if he could find it." The last of the original few who began with the laboratory in 1900 retired only last spring, at the age of seventy. He was a member of the executive staff.

There were at first two departments, for physics and engineering. Funds were low and equipment lacking, and, surprisingly enough, there was considerable opposition from some sections of industry: the Executive Committee had to make it clear that the laboratory had no intention of carrying out work that could be done by private consultants, and the policy of the laboratory is still to carry out for industry only those tests and investigations for which facilities do not exist elsewhere.

By the end of the first world war it had become obvious that the work of the laboratory must continue, and it was made the financial responsibility of the newly formed Department of Scientific and Industrial Research, under the Lord President of the Council. The Royal Society remained, and still remains, responsible for the scientific work, and the research program is submitted annually to the Executive Committee and the General Board, both appointed by the society. It is probably owing to the society's influence that, except in time of war, the mass of *ad hoc* work has never been allowed to oust fundamental research. The successive directors and the chairmen of the Executive Committee have always regarded the maintenance of this balance as one of their most important and most difficult tasks.

Sir Richard Glazebrook (who was knighted in 1917) retired in 1919 on reaching the age limit of sixty-five; Lord Rayleigh died in the same year. The next director was Sir Joseph Petavel, who died in 1936. Sir Frank Smith then combined the post with that of secretary of the Department of Scientific and Industrial Research, until the appointment in 1937 of Sir Lawrence Bragg. Bragg left in the following year to become director of the Cavendish Laboratory, Cambridge; Sir Frank Smith again took over until Sir Charles Darwin, a grandson of the author of *The Origin of Species,* was appointed in December 1938. Darwin carried the burden of responsibility and leadership through the

hectic years of the second world war and the no less difficult years that followed; he retired in August 1949 and is now living in Cambridge. On New Year's Day the following year, Dr. Bullard took office as the new director.

Succeeding chairmen of the Executive Committee after Lord Rayleigh's death were Sir Arthur Schuster; Glazebrook himself; Lord Rayleigh (the son of the first chairman); A. V. Hill, of University College, London, who carried out those duties throughout the war; A. M. Tyndall, of Bristol University; and now Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research.

The chief preoccupations of the laboratory are the science of measurement and hence the invention and development of measuring instruments of all kinds. Pure research, in the sense of seeking after knowledge for its own sake, has never greatly characterized it. Instead, in the investigation of practical difficulties the staff has frequently found an approach to problems of much wider scope, which have in turn led to programs of fundamental research. The laboratory's valuable studies in aerodynamics, for example, and its whole consideration of fluid flow originated in early attempts to discover the exact pressure of winds against the Forth Bridge, which had previously only been guessed at. King George V, then Prince of Wales, in opening the buildings at Teddington officially in March 1902, recalled that the object of the institution was "to bring scientific knowledge to bear practically upon our everyday industrial and commercial life," and the interaction of both those types of experience, scientific and "everyday," has been continuously fruitful.

The laboratory has certain legal obligations in addition to its program of research and test work. It carries out the statutory ten-year comparisons of the Parliamentary copies of the yard and pound

The visit of King George V to the laboratory in 1917. The King is seen in the center, standing behind one of his aides, with Dr. Glazebrook, on his right and J. E. Sears, later superintendent of the Metrology Division, on his left.

with their originals, which are kept in the Palace of Westminster, and has been entrusted with the British National Copies of the International Meter and Kilogram, the originals of which are kept at the Bureau International des Poids et Mesures at Sèvres, near Paris. It also takes part in the wider comparisons of standards at the Bureau International. It played a leading part in the researches and conferences which culminated three years ago in the international acceptance of the "absolute" system of electrical units, and is the custodian, on behalf of the Ministry of Fuel and Power, of the three British legal electrical standards representing the ampere, the volt, and the ohm. It holds apparatus for setting up the International Primary Standard of Luminance introduced in 1948; it maintains the national standard of load, the 50-ton dead weight machine; at present it is trying, with other physical laboratories, to make possible a system of standards for radioactive isotopes.

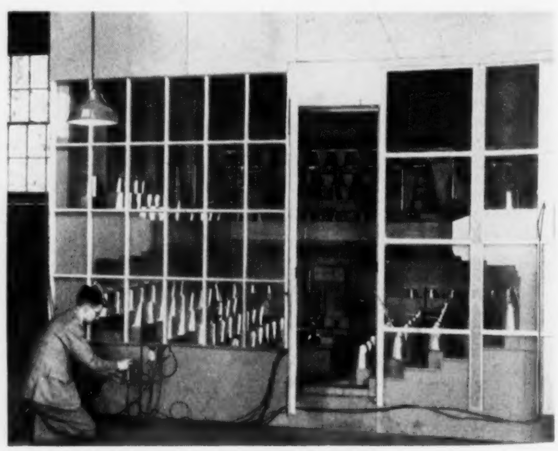
There are now nine divisions of the laboratory, concerned with aerodynamics, electricity, light (photometry and optics), mathematics, metallurgy, metrology, physics (which covers heat, radiology, acoustics, and ultrasonics), radio, and the design and propulsion of ships. There is also an Electronics Section, a High Temperature Mechanical Properties Section, and a Test House. The Engineering Division, which was one of the two original departments, was recently disbanded and most of its work is now done by the new Mechanical Engineering Research Organization of the Department of Scientific and Industrial Research, whose laboratories are at East Kilbride, near Glasgow.

The Physics Division was one of the two original departments, and most of its work continued to be carried out in Bushy House until 1931, when the present Physics Building was completed and occupied. B. W. Robinson is the superintendent.

The Heat Section of the division is chiefly concerned with the measurement of the thermal properties of materials, for which it has the widest range of specialized equipment in the country. Facilities exist for measuring the thermal conductivities of all classes of materials, including insulators for work on refrigeration, decking materials, refractories, ceramics, rubbers, paints, and plastics. Recent research in the section has included work on the electrical resistivity of gallium and the electrical and thermal conductivities of a range of porous bronzes. A hydrogen liquefier has been built for investigations into the properties of materials below the temperature of liquid nitrogen, and the electrical conductivities of specimens of graphite, nickel, cobalt, and chromium have been measured at liquid nitrogen temperatures. In the last year a small helium liquefier has been designed and built, and temperatures below 4° K have been reached.

The Temperature Measurement Section is working on new apparatus for determining the boiling points of water and sulfur and is investigating the reproducibility of the oxygen point. The section does a good deal of work on pyrometry, and an experimental model of a radiation pyrometer, using a lead-sulfide cell and working down to 100° C, has been giving satisfactory results. In another investigation, into the radiating properties of liquid steel, it has been found that for most cases, and with the exception of certain alloy steels, the measurement of the color temperature would be a reliable method of assessing the true temperature of a steel stream.

In the Acoustics and Sound Measurement Section, the range of frequencies in the analysis of noise has been extended recently to the lower ultrasonic and to subsonic frequencies, and fundamental investigation goes on into the origin of noise. Sound absorption and insulation are measured. The section has been working on problems of noise from aircraft (especially jet aircraft) and noise from aero-engine test houses and various noise problems raised by industrial firms, and has spent some time on investigating noise in ships and ways of reducing transmission from the engine rooms to the living quarters. Work goes ahead on the acoustics of hearing and its application to deaf aids.



A model of part of the debating chamber of the House of Commons, made at the laboratory for investigations into its heating and ventilation. Each pair of Members of Parliament is represented by a shielded electric light bulb.

In the Ultrasonics Section, methods have been developed of detecting flaws in metals and other materials by ultrasonic techniques; an improvement in echo power of nearly 1000 times has been achieved by using barium titanate instead of quartz transducers.

One of the tasks of the Radiology Section is a film badge service for assessing the weekly dose received by workers exposed to radiation. In 1950, the section tested about 30,000 such films: only five cases of overexposure to radiation were found, and, in each case, when a member of the section visited the establishment concerned he was able to reveal the cause. Dosimeters are calibrated for hospitals and laboratories in Britain and elsewhere. A 2,000,000-volt Van de Graaff X-ray generator is installed in a special building. The section has charge of the British copy of the International Radium Standard. It tests radium containers in terms of it, and urgent research is now being carried on to establish national standards of various radioactive isotopes.

In 1906 the metallurgical and chemical work of the Physics Division was transferred to a separate Metallurgy Division. During the war of 1914–18, this division was responsible for the invention of the well-known "Y-alloy" which later proved extremely important to the aircraft industry. The present superintendent is N. P. Allen, who visited the United States last year to present a paper at the symposium on the properties of metals at low temperatures, organized by NBS as part of the celebration of its fiftieth anniversary. His second-in-command, W. P. Rees, attended the World Metallurgical Congress in Detroit last October and presented a paper on the division's work on alloys of pure iron.

The Ferrous Section is studying the influence of interstitially dissolved impurities on the toughness of iron, and hopes finally to be able to suggest methods for making necessary economies in the use of alloying elements in steel with the least sacrifice of toughness.

One section of the division is studying, by means of X-ray diffraction and phase-contrast and optical microscopes, the elastic and plastic deformation of metals. A precision Geiger counter X-ray spectrometer was obtained last year, and a soft X-ray vacuum spectrograph is now being constructed. Another section is investigating alloy steels for use in the new electricity generating stations now being built in Britain, in which a general increase in steam temperatures is envisaged. In experiments on these alloys subjected to combined stress and corrosion by steam, the steam pressure has been raised to 1500 lb/in.^{2} and the temperature to 650° C. The work is done with the cooperation of steelmakers. In the course of the continuous systematic investigations into the properties and structure of alloys, some useful pioneer work has recently been done on the determination of oxygen in titanium and zirconium by the vacuum fusion method developed at the laboratory.

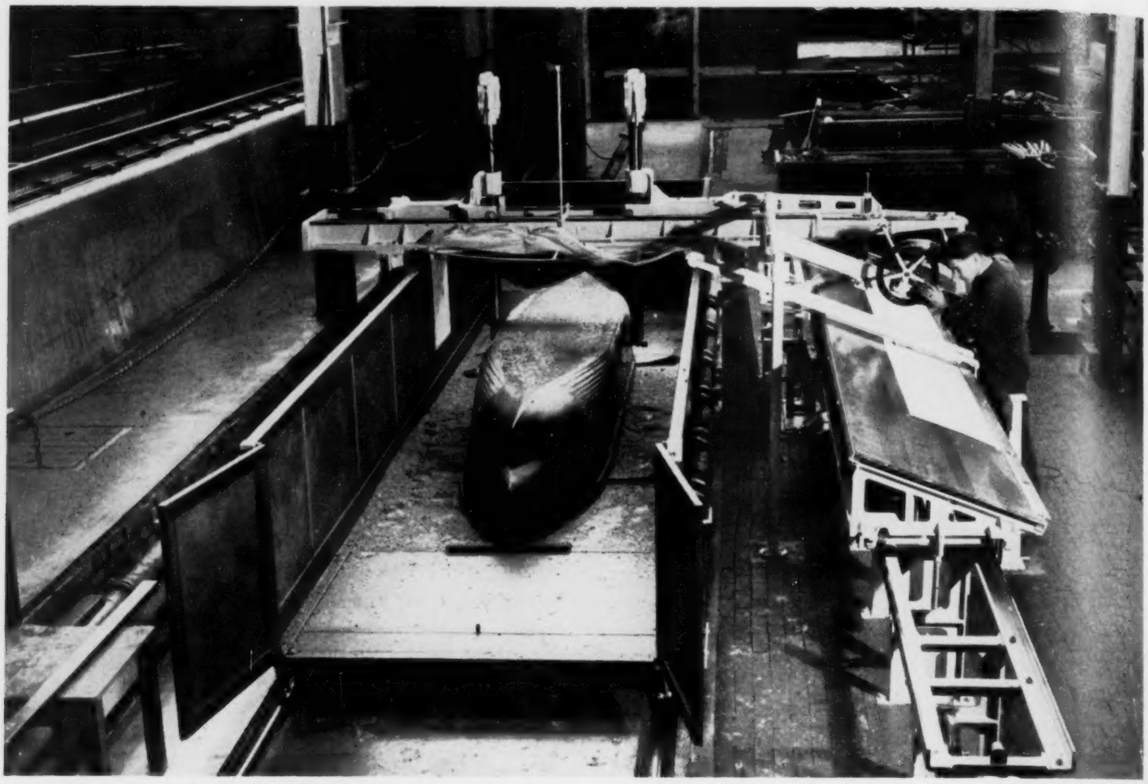
The Refractories Section has developed techniques for making all kinds of minute and elaborate ware for special purposes. During the past year it has been producing refractories for an apparatus for determining the properties of molten iron, a piece of research on which the Metallurgy and Physics divisions are cooperating.

About 80 British Standardized Samples of Steel are provided by the division every year.

In 1910, the late Sir Alfred Yarrow made the laboratory a very generous gift, and a ship-testing tank was built and the Ship Division established. There are now two tanks and a propeller tunnel for studying problems of cavitation; a third tank and another tunnel are to be built as soon as possible, some miles away from the laboratory because of the difficulty of finding a suitable site in the neighborhood. The No. 1 (Alfred Yarrow) tank is 550 ft. (168 m) long and 30 ft. (9 m) wide, with a depth along the middle of 12½ ft. (3.8 m). The No. 2 tank is longer and has a smaller cross section.

Accurate ship models are made of paraffin wax, which allows alterations to be made to test the effects of modifications to the hull. An average model measures 18 ft. (5.5 m) in length and when ballasted has a displacement of about 1 ton. The models are towed through the tank at various speeds by an overhead carriage, and the resistance is measured. Corrected for scale and change in skin friction, this provides a true measure of the resistance the ship would encounter, and from this the horsepower needed to drive it is calculated. Alterations to the hull are frequently suggested to the shipbuilders submitting the plans. In the early days, an improvement in efficiency of 30 per cent was quite usual, and even now an improvement of 10 per cent is sometimes obtained. At present more than 80 per cent of new British mercantile shipbuilding is based on designs tested by the division.

Among its researches, the division has done work on designs of rudders, on pitching, rolling, and wind resistance, on vibration of ships, and on laminar/turbulent flow problems. During World War II many problems were solved for the service departments, on mines, mine sweepers, torpedoes,



The rough ship model, cast in paraffin wax, is placed upside down in the open truck. The model is carried by the truck to and fro past two rotating cutters which can also be moved transversely. The model is thus shaped by a succession of cuts each in the horizontal plane at close vertical intervals, each cut being made to follow a line on the drawing pinned to the table. The model is afterward scraped down by hand to the cut lines to give a fair surface.

submarines, landing craft, and the Mulberry harbor.

The superintendent is J. F. Allan, who, with his deputy, G. Hughes, visited America during September last year to attend the Sixth International Conference of Ship Tank Superintendents in Washington, which was preceded by a meeting of the American Society of Naval Architects and Marine Engineers in New York. They also visited several research establishments in the United States and Canada.

Another division was formed in 1917 when the aerodynamic researches of the Engineering Division were transferred to a new Aerodynamics Division. The present superintendent is A. Fage. The division carries on fundamental research in the design and development of aircraft and researches on compressible flow and aerofoil characteristics at speeds approaching and exceeding that of sound. It also provides the secretariat for the Aeronautical Research Council.

There is a supersonic tunnel of 9.5 in. (30 cm) square section and a vertical induction flow tunnel of section 20 in. × 8 in. (50 cm × 20 cm), equipped with flexible walls, both of which tunnels have return-flow ducts; a third return-flow induction tunnel of section 9 in. × 3 in. (23 cm × 7.6 cm), which has been used for researches at 1.8 times the speed of sound; and a return-flow induction tunnel of section 18 in. × 14 in. (45.7 cm × 35.6 cm), which can be pressurized to three atmospheres and has a maximum working speed 1.8 times that of sound. A new High Speed Laboratory with three new tunnels is being built; the first tunnel, which is under construction, has a section of 36 in. × 14 in. (91.5 cm × 35.6 cm). There is also a whirling arm, 60 ft. in diameter and capable of a speed, relative to the air at the end of the arm, of 93 ft. per second. The division's older equipment includes a compressed air tunnel and five atmospheric tunnels.

Research goes on in the design of aerofoils, the principles of design of aircraft controls, aircraft "flutter," and the behavior of complete aircraft and their parts. A good deal of attention is given to aerodynamic theory and the comparison of theory with experiment. An inquiry recently started is the question of boundary-layer control by suction.

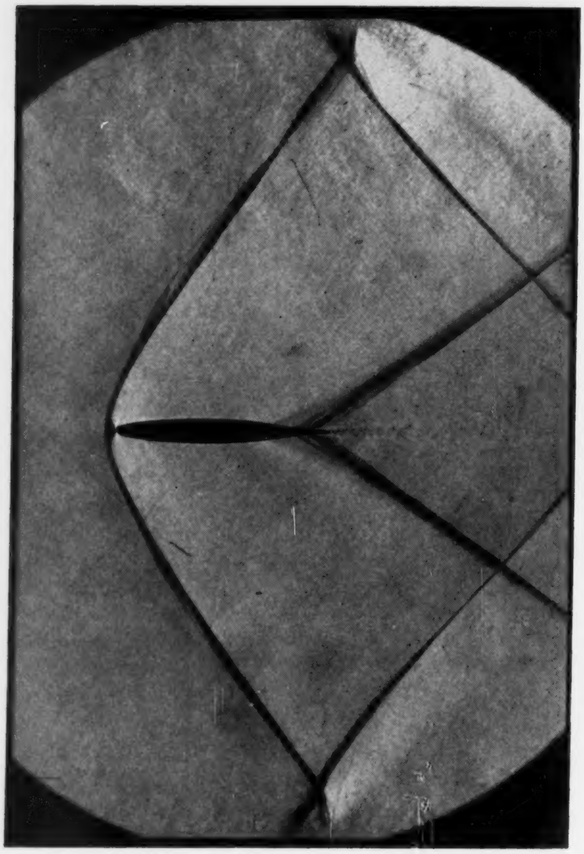
The division carried out aerodynamic researches

needed by the Ministry of Transport in planning the suspension bridge which is to be built over the River Severn, and a final design, incorporating the division's advice, has now been accepted. The officer in charge of work on suspension bridges, R. A. Frazer, was in America for four weeks last summer to attend an NBS symposium at Los Angeles and to visit laboratories and see suspension bridges.

Another job carried out in recent years by the division was to forecast the behavior of smoke plumes from the chimneys of the new power station at Bankside, London, by means of tests on models, and to advise on how high the chimneys would have to be to prevent the masonry of St. Paul's Cathedral from being damaged by the fumes.

Work in electricity, originally carried on by the Physics Division, became the subject of a separate Electricity Division in 1918. Its research now is concerned chiefly with electrical instruments, high-voltage work, and the maintenance of electrical standards. The superintendent is R. S. J. Spilsbury. L. Essen, of the division, was in the news about two years ago when he announced a new and probably more accurate figure for the speed of light based on work with radio waves. The radio wave is sent down a metal pipe and reflected backward and forward between the two ends. When the time of travel between the ends equals the time interval between successive waves an electrical resonance, which can be detected with very high precision, is established in the pipe. In this experiment the time interval is only one ten-thousand-millionth of a second, and the so-called cavity resonator need therefore only be a few centimeters long. The value obtained for the velocity was 299,792 km/sec.; this is 16 km/sec. higher than the previously accepted figure and was at first received with some skepticism; it has since been supported by an optical

The ship model attached to the moving carriage can be clearly seen in this picture. The operator in the center of the carriage is watching the automatic self-recording gear by means of which the behavior of the model can be examined under varying conditions. So great is the degree of accuracy with which these readings are made that the degree of curvature of the earth in 550 feet of water has to be taken into account.



Flow round a 12 per cent thick round-nosed aerofoil at zero incidence and a Mach number of 1.6.

method and by radar and is becoming widely accepted.

During the past year the division has made determinations, with a precision not previously attained, of the dielectric constants of the more important gases, including air, nitrogen, oxygen, hydrogen, carbon dioxide, and water vapor. The method depends on measurements of the frequency of a cavity resonator when it is filled with gas and when it is evacuated and is one of exceptional precision. The results for air are very important for microwave interferometry, with which the Metrology Division is concerned, and for radar. The division also does a great deal of widely varied investigations and tests for the British Electricity Authority and for industry.

The Metrology Division also began in 1918, as a breakaway from the Physics Division, with J. E. Sears, now retired, as superintendent. The present superintendent is his successor, F. H. Rolt, who is known by many North American engineers for his work at conferences on the unification of screw threads. The division is responsible for the maintenance of accurate standards of length, mass, and time, and of the more direct derivations such as area, volume, density, and pressure. It is also engaged in the development of precise engineering measurement, and there is a small but vigorous section pursuing basic research on mechanisms for automatic control. The physical measurements group standardizes, among other measures, surveying tapes and wires to an accuracy of one part in a million, and in these and all such scalar measures it undertakes to determine the thermal coefficients of expansion. The section produces diffraction gratings and special graticules on a ruling engine. Weights and balances used in scientific and industrial work are tested and standardized, specialized volumetric glassware and hydrometers are tested, and numerous problems of physical measurement are investigated for industry and research establishments.

Progress is being made in the search for a wavelength standard of length, and a study has been made at the laboratory of the effects of various pressures of argon used as a carrier gas with the isotope in the mercury 198 discharge lamps first introduced by the National Bureau of Standards. The mercury isotope (obtained from gold after irradiation in an atomic pile) and the krypton 84 isotope give spectrum lines most suitable for interferometric purposes. Mercury lamps are now in commercial production in Great Britain, and optical interferometers are regularly used at the laboratory for standardizing end gauges. The division also used one of its interferometers to calibrate the 12.5-cm displacement system of the adjustable cavity resonator used by Dr. Essen, of the Electricity

Schlieren photograph, taken with an exposure of 1 μsec, of the flow around a 10 per cent thick aerofoil (RAE 104) at 11° incidence and a Mach number of 0.75, in one of the high-speed wind tunnels of the National Physical Laboratory.

Division, in his recent determination of the speed of electromagnetic waves. A new departure is the foundation of a section to study the possibilities of applying microwave interferometry to length measurement. The measurement of lengths over about 50 cm would be far easier with microwaves than with light waves.

The Engineering Metrology Section concerns itself with gears, surface finish, precise measurement for engineers, the standardization of drawing office practice, and problems of quality control in mass production. It is also responsible for testing gauges and other measuring instruments.

During the second world war, the division tested huge numbers of gauges for the munitions industry. The work started in 1937; by the outbreak of war about 1000 gauges were being received each week, and the number rose steadily to 4000 a week in the summer of 1940. The pressure of this routine work was eased, however, when NPL control rooms were set up in the factories themselves, with a member of the NPL staff at each to certify that the testing was accurate. In addition, gauge testing centers were set up at certain technical colleges.

A highly specialized modern workshop is a part of the division and is of great importance in the construction of the prototype measuring equipment designed in the division and later to be developed by individual firms.

Radio research was started in the laboratory early in the first world war, and in 1933 a Radio Division was established with R. A. (now Sir Robert) Watson-Watt, who later developed radar, as its superintendent. Much of the early work leading to the use of radar was done in the Radio Division. The work of the division is now carried out for the Radio Research Board of the Department of Scientific and Industrial Research, and R. L. Smith-Rose, the director of radio research, acts as superintendent of the division. The Radio Research Organization has out-stations for ionospheric recording in many parts of the world, manned by its own staff or members of the NPL Radio Division. An interesting experiment has just been started in which members of the Radio Division and RRO have installed ionospheric recorders at the universities of Ibadan (Nigeria) and Khartoum (Sudan), which will be operated, not by Radio Division or RRO staff, but by members of the universities themselves. Results of recordings will be made available to the RRO, and the universities will have the use of the equipment for any program of research they may wish to plan.

The bulk of radio research work is now concerned with studies of wave propagation over an extensive band of frequencies and for varied conditions. The reason is that a detailed appreciation of the characteristics of the medium between transmitting and receiving points and of its effects on wave propagation is of first importance in choosing frequencies for particular purposes, in designing equipment, and in assessing the performance that may be expected from a communication system.

The division also provides an abstracting service, and abstracts of all the most important papers in radio and associated studies are supplied monthly for publication in *Wireless Engineer* in Great Britain and in the *Proceedings of the Institute of Radio Engineers* in America.

The division takes part in the work of the International Scientific Radio Union (URSI), the International Consultative Committee on Radiocommunication (CCIR), and the British Commonwealth Telecommunications Board. The superintendent attended the recent plenary meeting of the CCIR at Geneva as international chairman of the Commission on Tropospheric Wave Propagation.

The Light Division was formed in 1940 by combining the Photometry Section of the Electricity Division and the Optics Section of the Physics Division. L. A. Sayce is the present superintendent. The work of the division includes the study of optical instruments of all kinds and tests on many types, the study of vision and of light absorption, the measurement of color and of radiant energy, the maintenance of the standards of light, and—a recent addition—the production and duplication of diffraction gratings.

Two of the most interesting items of work done in the division in the past year were the development of a telecolorimeter for outdoor surveying in connection with problems of camouflage, and research into the production of transparent electrically conducting films on glass. A new method of preparing conducting films of stannic oxide, similar to the American "NESA" films, has been discovered and patented.

New methods of producing and copying diffraction gratings, suggested by Sir Thomas Merton, a member of the laboratory's Executive Committee, have been developed in the division during the past two years. The process consists, in essence, of cutting a very fine screw thread upon a cylinder and then "opening out" the helix upon a flat surface by means of a process employing a plastic replica. The workshop of the Metrology Division has been able to cut screw threads of very fine pitch by means of reduction gearing added to a small screw-cutting

lathe. The thread helix is impressed by a diamond on a cylinder of good surface finish, and threads as fine as 15,000/inch have been successfully produced. The inevitable periodic errors contained in the fine screw threads are removed by applying the "Merton nut," which is lined with strips of a resilient material such as cork, by means of which, on the opposite end of the cylinder, a second thread helix of a remarkable regularity is impressed. Two British firms have sent representatives to the laboratory to be instructed in the method, and an American firm has also proposed to send someone. This means that the immediate demands of users may soon be satisfied by commercial producers, leaving the division free to refine the processes involved.

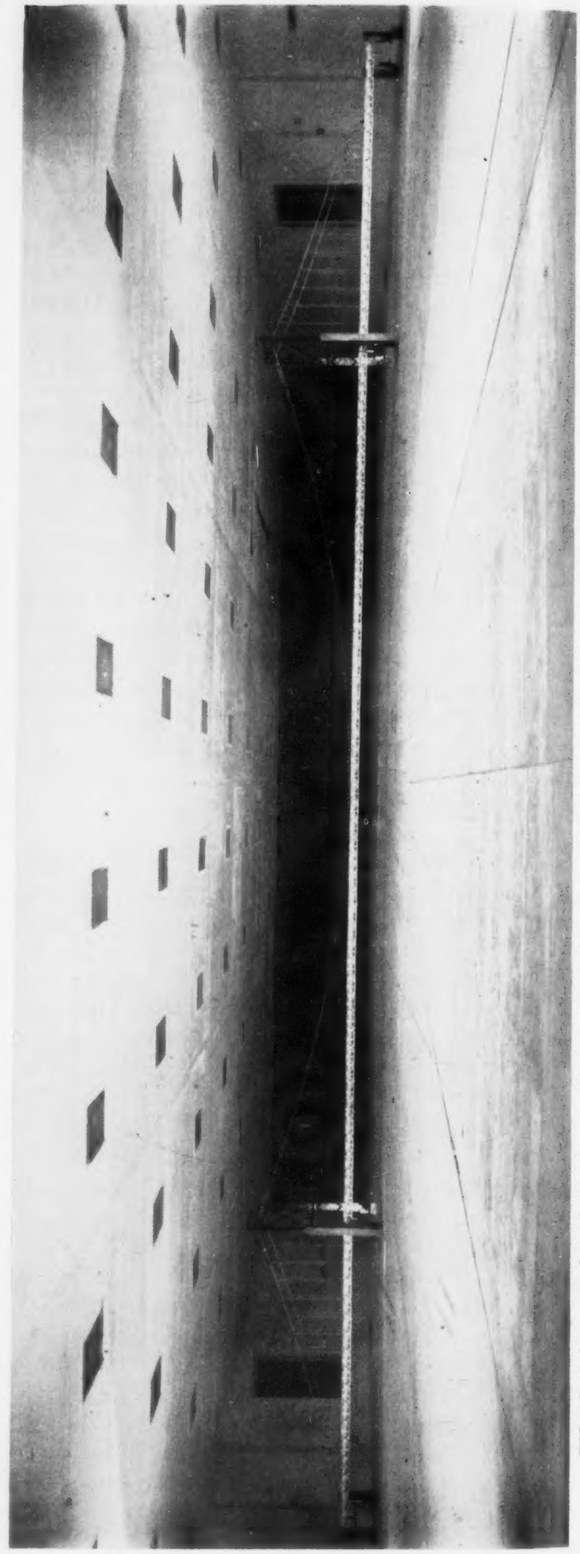
The Mathematics Division was established in 1945 and has been concerned with the application of mathematical and statistical techniques to scientific and industrial problems. The superintendent is E. T. Goodwin.

The General Computing Section carries out many widely different items of work for industry, the defense departments, government laboratories, and the universities, and does work for the Mathematical Tables Committee of the Royal Society.

There is also a Hollerith Section, which tackles computing problems by punched-card methods. The bulk of its work recently has been on statistical problems originating in the Statistics Section of the Division. The Statistics Section itself will shortly be transferred to the Ministry of Supply; a senior member of the staff acted as statistician to, and secretary of, an OEEC Productivity Team which visited the United States last autumn to study methods of inspection in mass production.

The Analytical Engines Section has recently had a new servo-connected 20-integrator differential analyzer made in Germany and is now installing it. The existing 8-integrator machine is always fully occupied on work for other divisions, outside laboratories, industrial firms, and the defense departments. The section maintains a useful advisory service on the design and use of differential analyzers and other analogue computing devices.

A section of the division has been cooperating during the past four or five years with the Electronics Section in constructing an electronic automatic computing engine (ACE), basically designed in the division. The pilot model of the ACE is now an operating machine and has been handed over to the Mathematics Division for use in computing problems.



Fifty-foot long model of the Severn Suspension Bridge, assembled for test in the specially built wind tunnel at Thurleigh, Bedfordshire.

Fifty-foot long model of the Severn Suspension Bridge, assembled for test in the specially built wind tunnel at Thurleigh, Bedfordshire.

The Electronics Section was set up in 1947, with F. M. Colebrook as officer in charge, to build the ACE, to advise on electronic devices, and to encourage their application to industrial processes. The ACE pilot model is an electronic digital computer, which is one of the fastest and most versatile computers in existence. A long calculation might involve 500 multiplications of two 7-figure numbers and would take several hours using a desk calculator; the ACE pilot model will do all 500 in about one second. It operates on the binary scale, in which the only digits used are 0 and 1. These are represented by the presence or absence of pulses of electrical energy generated at 1 million per second. The machine is "programmed" by means of Hollerith punched cards, and the results of the computation are translated into printed numerals. Although the machine uses the binary scale, problems can be put in and the answers taken out as ordinary decimals.

The section is now turning its attention to designing and building the full model of the ACE, which will have greater speed and a larger memory.

The laboratory's Test House was opened on January 1, 1949, as a center for the routine testing carried out until then by the scientific divisions. Barometers, hydrometers, clinical and meteorological thermometers, viscometers, volumetric glassware, petrol jets, and engineers' precision instruments are tested there, and at an out-station in Lambeth every taximeter in London is periodically checked. Testing methods are determined by the divisions, and H. Bowley, the officer in charge of the Test House, is responsible for economy in time and increased efficiency of methods, and for ensuring mobility of staff among his various sections.

The High Temperature Mechanical Properties Section is a new independent section formed last year from the Creep of Metals Section of the old Engineering Division, and it will eventually be transferred to the Mechanical Engineering Research Organization in Scotland. The study of the creep and fatigue of metals at high temperatures has gone on in the laboratory for very many years, and the section continues these researches. The officer in charge is H. J. Tapsell.

E. C. Bullard, present director.

The laboratory now has a staff of about 1200 people, of whom 650 are directly engaged on the scientific work of the establishment; of these, about 250 have university degrees or equivalent qualifications. The clerical and executive staffs number about 160, and there are some 100 mechanics, whose knowledge and experience make possible the construction of much of the apparatus designed by the scientific staff. A considerable number of people is also needed, of course, to maintain the buildings and grounds. Visitors say that the laboratory, surrounded on three sides by the green trees of Bushy Park, is like a small and thriving town.

SCIENCE ON THE MARCH

PSYCHOBIOLOGICAL PERIODIC TABLE OF CHEMICAL ELEMENTS

WE ARE still a long way from being able to say which of the 96 known chemical elements are necessary for optimum growth and development of living systems. Even less do we know about the specific physiological functions of the chemical elements. But there is considerable evidence that these physiological functions relate the chemical elements to each other in patterns that closely resemble the periodic system developed by the inorganic chemist. There would seem, then, to be some value in stating the current biological knowledge of chemical elements in terms of their placement in the periodic table.

In his recent book *Physical Biochemistry,* Bull presents "what one might call a biological periodic table which includes only those elements occurring naturally in living tissues." He includes 20 elements and arranges them within the framework of Mendeleev's version of the periodic table.

From the fields of psychophysiology, agriculture, and medicine, there is evidence that supports the inclusion of some elements in addition to the 20 Bull lists in his Biological Periodic Table. In this paper we shall cite some of this evidence and restate the Biological Periodic Table to include these additional elements.

A number of criteria might be used to determine what elements to include in the Biological Periodic Table. We might include all elements (1) that are known to be essential to all forms of living systems, or (2) that are known to increase the efficiency of specific forms of living systems, or (3) that are known to have a part in some physiological processes in some living systems.

Other criteria have been used by other workers. Frey-Wyssling includes in his biological periodic table 19 elements that are essential to plants. Thatcher's selection also is on the basis of essentiality for plants. Webb and Fearon include 38 elements in their table, the selection being on the basis of the occurrence of these elements in organisms, regardless of whether the elements serve a function or are merely accidentally accumulated. Robinson, in reviewing the literature on elements found to occur in plants, names 60 elements, but does not attempt to establish their relationships within the periodic system.

In this paper we have chosen the third criterion listed above—i.e., we shall include in the Biological Periodic Table all elements that are known to have a part in some physiological processes in some living systems. It seems necessary to use this criterion if we are to discover the biologic relations between the elements. For, in considering the utilization of inorganic elements by living systems, we have to think of living systems as forming a chemical continuum, from the simplest microorganisms to the more complex forms of plant and animal life.

The need for thinking of living systems as a chemical continuum is perhaps most clearly illustrated in reference to the element molybdenum. There is no evidence that molybdenum can be directly utilized by any of the higher forms of animal life. But it is becoming increasingly evident that there could be no higher forms of animal life if molybdenum were not utilized by microorganisms and by plants to transform nitrogen into forms that can be used by animals for proteins. The biological relationships between molybdenum and the other elements can be stated in terms of these nitrogen-fixing functions.

There is no conclusive evidence that lithium is essential to any living organisms. But there is evidence from the field of psychophysiology that lithium, from a physiological, as well as from an inorganic chemical point of view, is closely related to the other elements in Group I of Mendeleev's version of the periodic table. Its biological relationships to the other elements can be stated in terms of sensory experience, making use of the chemical sense of taste.

There is no valid reason for not making use of our chemical senses for purposes of scientific study of the interrelationship of chemical elements. "The object of all science, whether natural science or psychology, is to co-ordinate our experiences and to bring them into a logical system" (Einstein). And although the olfactory sense is rather decadent in man, it is still a more sensitive instrument for the identification of some chemical substances than is the spectroscope.

From a phylogenetic standpoint, the olfactory sense is the oldest of the "distance-receptive"

mechanisms, and it provides the evolutionary foundations for the development of the cerebral hemispheres. To be experienced as odors, the inorganic elements must first combine with tissues or fluids of the olfactory membranes and form organic compounds. These organic compounds are then recognized and identified as indicative of different kinds or conditions of vegetal or animal tissues. And so it would seem that a complete Biological Periodic Table should include all the elements that elicit the olfactory response.

Olfactory responses are divided into two major classes: smell, as it is experienced by means of the nose, and the common chemical sense, an irritation that affects not only the nose, but also any part of the mucous membrane of the body with which the irritating chemical substance comes into contact. This common chemical sense is quite distinct from smell and usually causes a reflex action, such as coughing and sneezing, and closing and watering of the eyes. Phylogenetically, the common chemical sense antedates smell and taste.

The four primary taste qualities—sweet, salt, sour, and bitter—may also be thought of as indicating different kinds or conditions of organic matter. And so it would seem justifiable to include in the Biological Periodic Table all the elements that elicit taste experience.

On the basis of this psychophysiological evidence, we can add the following elements to Bull's Biological Periodic Table: lithium, rubidium, caesium, beryllium, lead, arsenic, antimony, bismuth, selenium, and tellurium. From studies of plant and animal nutrition there is evidence to support the inclusion of rubidium, beryllium, arsenic, and selenium. From the medical sciences there is evidence to support the inclusion of lead, arsenic, antimony, and bismuth. Studies of plant and animal nutrition indicate that the following elements also may be included in the table: silver, boron, gallium, molybdenum—and possibly silicon and aluminum.

When the above additions are made to Bull's table, we find that all the columns of Mendeleev's periodic table are represented, with the exception of the first vertical column and the last horizontal column. And it begins to look as though the process of arriving at generalizations about the biological relationships between the elements is not greatly facilitated by the use of this particular arrangement of the periodic table.

TABLE 1

Psychobiological Periodic Table of Chemical Elements*

I	II	III	IV	V	VI	VII
					55 **Cs**	87 Fr
					56 Ba	88 Ra
					57 La	89 Ac
					58 Ce	90 Th
					59 Pr	91 Pa
					60 Nd	92 U
					61 Pm	93 Np
					62 Sm	94 Pu
					63 Eu	95 Am
					64 Gd	96 Cm
					65 Tb	
					66 Dy	
					67 Ho	
					68 Er	
			19 **K**	37 **Rb**	69 Tm	
			20 **Ca**	38 Sr	70 Yb	
			21 Sc	39 Y	71 Lu	
			22 Ti	40 Zr	72 Hf	
			23 **V**	41 Cb	73 Ta	
			24 Cr	42 **Mo**	74 W	
			25 **Mn**	43 Tc	75 Re	
			26 **Fe**	44 Ru	76 Os	
			27 **Co**	45 Rh	77 Ir	
			28 Ni	46 Pd	78 Pt	
	3 **Li**	11 **Na**	29 **Cu**	47 **Ag**	79 Au	
	4 **Be**	12 **Mg**	30 **Zn**	48 Cd	80 Hg	
	5 **B**	13 **Al**	31 **Ga**	49 In	81 Tl	
	6 **C**	14 **Si**	32 Ge	50 Sn	82 **Pb**	
	7 **N**	15 **P**	33 **As**	51 **Sb**	83 **Bi**	
	8 **O**	16 **S**	34 **Se**	52 **Te**	84 Po	
1 H	9 **F**	17 **Cl**	35 **Br**	53 **I**	85 At	
2 He	10 Ne	18 A	36 Kr	54 Xe	86 Rn	

* Adapted from Kendall's periodic classification of the elements. Elements that are known to have a part in some physiological processes in some living systems are in bold face. The number to the left of each element is its atomic number.

In Table 1 we have tried arranging these apparently biologically significant elements in another way. This arrangement of the periodic table is taken from Kendall's periodic system (an adaptation of Thomson's system) and appears to provide a more meaningful outline of the relations between biological function and atomic structure.

Arranged in this way, the table takes the form of one incomplete half of a pyramid. The inert gases -helium, neon, argon, krypton, xenon, and radon —form the base of the pyramid. These gases are colorless, odorless, and tasteless, and there is no evidence that they have any part in physiological processes.

Beginning at the base of the pyramid, we find an orderly progression upward from the inert gases; to the halogens—fluorine, chlorine, bromine, iodine—which stimulate the common chemical sense (the most primitive of the chemical senses) and which can be smelled; to the next column, which contains elements that irritate and that are odorous; to the nitrogen column, the elements of which are odorous and also have taste; to four columns which contain elements that have taste, and these tastes are graded upward from sweet to bitter to salty.

Looking at the vertical columns, we find that, with the exception of the inert gases, all the elements in the first three vertical columns are probably biologically significant. Hydrogen, oxygen, nitrogen, and carbon—which are the basically essential elements in all forms of living systems—all appear in the first two vertical columns.

In column IV—in the third level of the pyramid —appears calcium, which forms the backbone of the vertebrates. The fourth level of the pyramid is characterized by the appearance of the more radioactive elements.

We might hazard the guess that the different levels of this pyramid are correlated with distinct levels of biologic development, and that the progression in complexity of atomic structure is related to progression in biological complexity in a periodic, or rhythmic, pattern. Reading downward from the top of each vertical column, the second element appears to be the one that defines the characteristics of the level of biologic complexity. The elements lower in the vertical columns appear to consolidate and to elaborate these gains in complexity.

Steinberg's limiting concept of the biological essentiality of chemical elements presupposes that the biological evolution that has been in progress for countless millions of years is at, or very near, its end and that the human species, as it exists today, is the last, best product of this long evolutionary process. Looking at ourselves objectively, we might pause to reflect that there is still some room for improvement. These improvements have, in the past, been associated with basic changes in the chemical-balance requirements of organisms. We might suppose that they will continue to be in the future. So far as we know, nature has not handed in her resignation as a biological experimenter. It is true that human beings have taken over a large share of the responsibility for alterations in the chemical balance of their environment. But if, in so doing, we fail to perceive the positive directions of the evolutionary process and are unable, therefore, to move in those directions, this does not mean that the evolutionary process will come to an end with the "more crystallized status of man" that Seidenberg predicts in his ***Posthistoric Man***. There are still plenty of fish in the seas, and the chemicals required for new experiments in living forms are rapidly being washed into the seas.

The prospect of endlessly reiterating the life cycle of a human being is not especially appealing. It is with something of relief, therefore, that we are able to discover a fundamental error in Steinberg's method of arriving at his conclusion that not more than 25 or 26 of the chemical elements will ever be found to be biologically essential. His classification of the elements into macronutrients, intermediate, and micronutrients is not in agreement with the facts of quantitative measurements of these elements as they are utilized, or accumulated, by organisms. In fact, in order to fit the data into his table of correlations, he classifies some of the micronutrients as macronutrients. When Steinberg's data are corrected, to bring them into line with the facts of quantitative analyses of the nutrient elements, the correlation between biological essentiality of the elements and their atomic structures is less simple than Steinberg concluded. A further limiting factor in his method of correlation lies in his choice of arrangement of the periodic system of the elements. His arrangement of the periodic system is based on present knowledge of shell and subshell structure of the atoms, in somewhat the same way that Table 1 is. But a possible source of error in Steinberg's data is the fact that he divides the system into smaller periods, on the basis of a more detailed analysis of subshell structure. There is some doubt that present knowledge of atomic structure is accurate enough to warrant such reliance on these details.

The fact that a relationship does exist between the biological functions of chemical elements and their placement in the periodic system has been

noted with remarkable regularity by workers in the biological sciences: in nutrition, biogeochemistry, pharmacology, agronomy, psychophysiology, physical biochemistry. These isolated notations have not been brought together and integrated into a meaningful whole. It may, however, be necessary to do this in order to arrive at workable hypotheses concerning these relationships. And it seems likely that they are the most solid ground upon which the physical, biological, and psychological sciences can meet and solve their mutual problems.

This common meeting ground of the sciences has been made more solid by the development of electron micrography, which makes possible the direct objective study of correlations between complex personality constructs and the structural characteristics of minute chemical units. Research (unpublished) now in progress, on the use of electron micrographs as material for a "projective" psychological test (somewhat in the way that ink blots are used in the Rorschach Test), suggests the possibility that the structural designs of mental and of physical phenomena may form parallel systems that can be mathematically correlated.

The responses that are made to the electron micrographs of different chemical substances vary from one person to another. Yet there is apparent some patterning of these responses that is determined more by differences in the chemical substances than by differences in the individuals. In other words, there is some inherent similarity in the responses that different individuals make to a particular electron micrograph, and this similarity is not entirely masked by the individual characteristics of the responses. The same phenomenon occurs in the Rorschach Test. Certain of the ink blots tap specific types of personality constructs. In the case of the electron micrographs, it appears to be the inorganic rather than the organic chemical substances whose structural characteristics are more closely related to the more universal, less personal, personality constructs. The mental phenomena elicited by certain of the electron micrographs are difficult to define except in terms of Jung's hypotheses concerning the "collective unconscious."

Jung's more intimate acquaintance with the psychoses provided him with a deeper insight into the workings of the collective unconscious than is found in the writings of Freud. And although we shall avoid, insofar as possible, the use of Jung's terminology, some of his hypotheses have a direct bearing on the subject of this paper. According to Jung,

> As the body is a sort of museum of its phylogenetic history, so is the mind. . . . The unconscious psyche is not only immensely old, it is also able to grow unceasingly into an equally remote future. . . . The anima and animus . . . obviously live or function in the deeper layers of the unconscious mind, in the phylogenetic substructures of the modern mind, the so-called collective unconscious.

The anthropomorphic terminology that permeates all the writings of all current schools of psychoanalytic thought, although it has its practical usefulness in therapy, tends to becloud the theoretic aspects of psychology. The "collective unconscious" in its larger meanings is a "timeless consciousness" that simultaneously experiences all possible relationships between the elements that form its content. Perhaps Levy-Bruhl's phrase *représentations collectives* is a more fortunate way of denoting the contents of this timeless consciousness. And, if we think of these *représentations* as being the most elementary of conscious concepts, we are perhaps better able to think our way through to the working relationship between this "timeless consciousness" and the "individual conscious" levels of mind. According to Herbart, these simple, elementary representations, or concepts, are not forces in themselves. They become forces only when they meet with opposing representations or concepts. Then we may think of all forces—energy, electricity, by whatever name known—as being the result of opposition, or resistance, between these elemental representations in the timeless consciousness. If these elemental representations are the building blocks of mind, of matter, and of energy, then it is not perhaps too much to expect that we may find ways of discovering the laws of interchangeability of these three manifestations of the timeless consciousness. The interchangeability of energy and of matter has already been demonstrated. The interchangeability of consciousness, of energy, and of matter is the problem with which psychosomatic medicine and psychic research are concerned.

Our finite minds may never be able to conceive of how the timeless consciousness, in which an infinite variety of relationships is simultaneously existent, can be both harmonious and chaotic. Yet it is necessary to hypothesize this simultaneous existence of a state of complete harmony of relationship and of complete chaos of relationship. For, if only the state of complete harmony of relationship existed, there could be none of the phenomena that we know as energy and as matter. And, if energy is once assumed to become generated in a consciousness that encompasses all possible and potential relationships, then it is not conceivable that

the energy can cease to operate until all these relationships are again in a state of harmony. But since there is no time sequence in a timeless consciousness, the infinite degrees of harmony and of chaos must exist simultaneously.

It is only mathematically, in terms of relationships between degrees of frequency of occurrence, that we can come anywhere near a comprehension of this. If we think of timeless consciousness as being composed of infinitely small elementary representations, which are infinite in number but limited in variety, then it is possible, mathematically, to assume an infinite potential number of combinations of these elementary representations. All these potential combinations could exist simultaneously and harmoniously.

But if each of these combinations of the elementary representations is existent in a consciousness, then each combination must be unique. For the essential characteristic of consciousness is uniqueness. The quality of being conscious is synonymous with the quality of being unique. Complete identity between two conscious experiences is impossible because, if they were identical, the experiences would be known to consciousness only as one experience. For the finite mind, this experiencing of uniqueness, or of consciousness, is in relationship to things external to itself. But, since the timeless consciousness encompasses all things, its experiencing of uniqueness must, we would assume, come from the uniqueness of the individual units within it rather than from a comparison with things outside itself, since nothing is outside of it. And so it becomes necessary to assume that within the timeless consciousness there is only one of each of the potential combinations of the elementary representations.

Contradictory though it may seem, this means that there would be varying degrees of probability that the combinations would exist, for the complex combinations would contain within them simpler combinations. So the frequency of occurrence would be in inverse relation to the degree of complexity of the combination of the elementary representations. And the greater the degree of complexity of the combination of the elementary representations, the nearer it approaches to the totality of the timeless consciousness.

Something of the same relationship can be observed in the finite mind. Experiences that are oft repeated (but not identical, since they occur at different points in the time sequence) become less clearly conscious, whereas a more unique experience will be more clearly conscious—provided, of course, that it is not entirely unrelated to what is already in consciousness, for in that case it could not be consciously experienced.

And so we see that the quality of consciousness, or of uniqueness, has two aspects—that of similarity and that of difference. Nothing can be experienced in consciousness unless it is different from all other things that are in consciousness, and yet neither can it be in consciousness if it does not have some similarity to the other contents of consciousness. In measuring intelligence, we find that the capacity for recognizing similarities and differences is one of the most accurate measures (if not the most accurate measure) of the degree of conscious intelligence.

For the finite mind, this increase in capacity for recognizing similarities and differences progresses in two directions—in the direction of recognizing similarities and differences between the elements of its individual consciousness and in the direction of recognizing similarities and differences between itself and things external to itself. For the timeless consciousness, these two processes would, we should think, be one and the same—a total awareness of all relationships of similarity and difference that, in its completeness, includes an active awareness of the nature of consciousness, or of existence, as such, as contrasted with nonexistence. A complete awareness of the nature of existence must include a complete awareness of the nature of nonexistence. It is the contrast between waking and sleeping that makes us aware of the fact that we are conscious while awake. The infant learns of the existence of food because at certain times he is acutely conscious of its nonexistence.

In the timeless consciousness, as we have hypothesized it, degrees of positive and of negative consciousness might be assumed. These negative degrees of consciousness are not the same thing that is referred to as unconsciousness, for the positive and negative degrees of consciousness are both a part of consciousness. They might be thought of as opposite phases of waves. The points at which the positive and negative phases of the waves meet define a linear, or a curvilinear, function that might be called the threshold for positive degrees of probability of existence.

We might think of the points that are encompassed by the two phases of the wave curves as being opposed concepts, in the sense that Herbart uses this phrase. These opposing concepts (of the positive and negative degrees of probability of existence) encounter each other at the threshold of positive probability.

According to Herbart,

> Concepts become forces when they resist one another. This resistance occurs when two or more opposed concepts encounter one another. . . . To the resisting concept, however, its action is quite accidental; it adjusts itself to the attack which is mutual among concepts, and which is determined by the degree of opposition existing between them. This opposition may be regarded as that by which they are affected collectively. In themselves concepts are not forces. . . . The presentation (concept) must yield without being destroyed, i.e., the real concept is changed into an effort to present itself. . . . When a concept becomes not entirely, but only in part, transformed into an effort, we must guard against considering this part as a severed portion of the whole concept. It has certainly a definite magnitude . . . but this magnitude indicates only a degree of obscuration of the whole concept. When a sufficiency of opposition exists between concepts, the latter are in equilibrium. They come only gradually to this point. The continuous change of their degree of obscuration may be called their movement. . . . The statics and mechanics of the mind have to do with the calculation of the equilibrium and movement of the concepts. . . . All investigations into the statics of the mind begin with two different quantitative factors, viz., the sum (or the aggregate amount) of the resistance and the ratio of their limitations.

In the system that we have described as timeless consciousness, this would mean that there would be a constant movement back and forth across the threshold for positive probability. These waves of movement would enclose circles of greater or lesser circumference, depending on the nature of the probability curve in which they were generated.

The elementary representations are not forces in themselves; they are in a state of complete internal harmony since they are actually representations of the total of the timeless consciousness. And since each of these elementary representations is exactly like every other one, the only way that opposition between these concepts or representations can be imagined is in terms of their differing positions on a probability curve.

Perhaps the only way that we can conceive of this system is by thinking of each of the elementary representations as having an infinite number of more elementary representations, which in turn have an infinite number of even more elementary representations. It would be, in other words, a system in which the decrease or increase in the power to which its elementary units are raised does not alter the nature of the elementary units, or the nature of the system. If this line of thought is continued, it leads to nothing except an abstraction concerning probability relationships. But the question of which came first—the abstract or the concrete manifestations of the timeless consciousness—is not a valid one, since there is absolute continuity and absolute simultaneity within the system.

Although the above hypotheses are unclear and undoubtedly contain many inconsistencies, the need for them is demonstrated by the fact that we are able to use these as the basis for a possible explanation of the interrelations between four known constants in the physical world. It will be said that some such system might be hypothesized without the inclusion of the idea of a timeless consciousness. But it is only by the use of Herbart's theories concerning the laws of the statics and mechanics of the mind that we are able to explain the generation of energy in a system whose units are not forces in themselves. We must either imagine a system in which the units are units of consciousness or in which they are units of some undefined force. It seems unnecessary to burden the hypothesis with the assumption of an unknown force, when the existence of consciousness is so self-evident.

Herbart's imposing mathematical treatment of the subject of psychology was based largely on his observations of the mental processes of young children. Yet so accurate were his observations in this one area of psychology that the theories that arose from them may be applied, with only minor technical changes, to any of the more recently developed branches of the science. The first real textbook of psychology, written by Herbart in 1816, comes nearer to integrating the most recent findings in psychology and physics than do any of the more recent schools of psychological thought. "Modern" psychology has been led the long way round by Kant's ideas concerning a dichotomy between cognition and conation. Perhaps a fuller appreciation of Herbart's theories was not possible prior to Einstein's demonstration of the larger significance of Planck's constant, and Freud's demonstration of the significance of the unconscious.

Let us begin with Herbart's statement that "All investigations into the statics of the mind begin with two different quantitative factors, viz., the sum (or the aggregate amount) of the resistance and the ratio of their limitations," and see in what ways this helps us to understand the interrelations between four known constants: (1) Planck's constant, $h = .00000000000000000000000000655$; (2) $e = 2.718282$; (3) $\pi = 3.141593$; and (4) the value for the threshold of sensory experience, which is (15, approx) $(10)^e$—expressed as molecular weight in the case of the olfactory sense, as vibrations in the case of the auditory and vibratory senses, and as units of intensity of illumination in the case of visual dark adaptation.

Of these four constants, the two that are expressions of limits, e and the threshold for sensory experience, appear to be related to each other logarithmically; 2.718282 is the natural logarithm

of 15.1543. The other two constants, h and π, appear to be correction factors used to compensate for a constant error in sensory perception that is due to the limits of the sensory threshold.

The constant e is the only one of the four that is calculated solely on the basis of mathematics and is therefore the only one not subject to errors in sensory perception. We might expect to derive more accurate estimates of the other constants in terms of their relationships to e. If we are right in assuming that the limit for the threshold for positive probability in the timeless consciousness is the constant e and that the limit for the threshold of sensory experience is $(e)^e(10)^e$, then we would expect that exact measure of the sensory thresholds would very closely approximate $(15.1543)\ (10)^e$.

Since we have assumed that energy is generated by the opposition, or resistance, of units of consciousness, it is interesting to note that the reciprocal of 15.1543 is .06598 (which very closely approximates Planck's constant multiplied by $(10)^{-26}$). Planck's constant has been variously estimated as $(.655)\ (10)^{-27}$ or as $(.6624)\ (10)^{-27}$. There is the possibility that it can be more accurately estimated in terms of its relationship to the threshold of sensory experience, in which case we might expect that the exact value of Planck's constant is h = .0000000000000000000000000006598.

Another interesting relationship between the constants is this: the sine of an angle of approximately 41° is .6598; and the fractional part of the constant e (.718282) is the number of radians in an angle of approximately 41°. It would seem that the limit $e = 2.718282$ is an expression of the number of radians in the units which are the unique limits of the threshold of positive probability in the system that we have described. Let us think of the timeless consciousness as being circular in nature (really spherical—though for purposes of simplification we shall think in terms of a circle), though not exactly in the sense that we ordinarily use the word circular. Let us imagine a circle in which it is unnecessary to use the correction factor π in order to define the relationships between radius and circumference. Such a circle might have 7 radians instead of the 6.2832 that we know. One radian = 57.2958°, and when this number is multiplied by 7 the result is a circle with 401.0706°—that is, a circle with 41.0706° in addition to the 360° that we know about. If we think of these extra 41.0706° as being in the form of waves or folds in the surface of the circle, the next assumption would be that these waves account for all the phenomena that we know as matter, as energy, and as individual conscious experience. If this is true, then the relationships between the constants e and h and the angle of approximately 41° become significant.

These folds in the circle, corresponding to an area of 41.0706°, would extend from the center of the circle to its outer limits. As the length of the radius increases, the height of the waves increases. The relationship between the height of the waves and the radius of the circle would be expressed in terms of the sine of the angle of 41.0706°. The height of the waves would reach a minimal value at or near the center of the circle, and we might expect that Planck's constant is an expression of the energy represented by the minimal point in this series of waves—i.e., at or near the center of the circle.

If the constant e is an expression of the number of radians in the units that are the limits of this system, then it can be seen that these units contain different amounts of energy according to their location within the circle. If the folds corresponding to the extra 41.0706° are assumed to be a continuous series along one diameter of the circle, then the unit of 2.718282 radians that would contain the greatest amount of energy would be the one that included the full length of that diameter plus the area of 10.26765° on either side of that diameter.

For this unit of maximal energy value, the angle between its outer limits and the diameter that is perpendicular to the polar diameter could never be smaller than 22.4366°. Since there is a constant movement back and forth across the polar diameter (the threshold of positive probability) this angle would actually be slightly larger than 22.4366°. The difference between the exact measurement of this angle and 22.4366° would be a measure of the amount of movement across the polar diameter, which could be expressed as the amount of energy within the system. The greatest amount of activity would center around the two extremities of the polar diameter, which is what occurs in a magnetic system. In this connection, it is interesting to note that the inclination of the earth to the plane of its orbit is approximately 23.5°, and that the maximal fluctuation of this angle is approximately 2.3°.

When we think of the periodic system of chemical elements in relation to this system of the timeless consciousness, we must assume that in final analysis the periodic system will be found to be curvilinear, perhaps almost circular, in nature; that the polar diameter of the circle will be the line across which radioactive changes in the elements move; that hydrogen will probably be at or near the center of the circle; and that the arrangement

of the elements within the system will be such as to form an orderly series according to three characteristics of the chemical elements—atomic number, molecular weight, and wavelength. The difficulty in devising such a system lies in the fact that, although the wavelength characteristics of the chemical elements are their most definitive, there is, as yet, no discernible relationship between the known facts about wavelength characteristics of the elements and their atomic structures.

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SMO ON THE AIR

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BOOK REVIEWS

SUMER IS ICUMEN IN, GROWETH SED, BLOWETH MED

Modern Gardening. P. P. Pirone. x + 371 pp. $3.50. Simon & Schuster, New York. 1952.

ALTHOUGH at first making the reader a little apprehensive by its subtitle (Miracle Drugs) and its preface that stresses modern chemistry's recently introduced synthetics, happily this book turns out to be a safe, sensible, and entirely practical vade mecum for the up-to-date gardener. Chapter 1, Wonder Drugs for Better Gardens, is a sound and acceptable discussion on plant feeding. Possibly the author has done plant science a service by jarring our complacent acceptance of the roles of nitrogen, potash, phosphorus, calcium, and the minor elements in plant nutrition. In reality, these chemicals *are* wonder workers in their influence on the unfolding of plant life. Chapter 2, Some Planting Fundamentals, reveals to the amateur the know-how for lawn-making, home landscaping, tree planting, and flower growing. Chapter 3, Foliage Feeding, is an intriguing account of practice following closely on the heels of experimentation. Chapter 4, Spraying Weeds to Death, gives an up-to-date résumé of experience with 2,4-D and other selective herbicides. The reviewer wonders what will be left when, as stated on page 80, beets are sprayed with 2,4-D salt. Ten pages are required to list the weed killers that confront the puzzled amateur, but the statement for each of active ingredients and their percentages should help.

In Chapter 5, Chemical Warfare on Insects, reference is made to Paris green and kerosene emulsions, the insecticides of the past century, and to lead arsenate, nicotine, rotenone, and pyrethrum, specifics of the last few decades that are now being displaced by synthetics such as DDT and the organic phosphates. The chapter gives in nontechnical terms a résumé of control measures against certain insect groups, followed by a tabulation of methods of control for insects attacking trees, shrubs, flowers, vegetables, and lawn grasses. Chapter 6, Medicines for Ailing Plants, is a companion chapter on control of plant pathogens. In sixteen pages the author discusses losses from plant diseases and causation of disease, and lists the remedies in the plant doctors' armamentarium. Then compatibilities of insecticides and fungicides are tabulated, followed by a six-page tabulation of important diseases of trees, shrubs, and flowers and their control. The chapter closes with a guide to the fungicides. This is a table occupying twenty-three pages and runs the gamut from Acme Bordeaux to Ziram. Here again the puzzled amateur is aided. Chapter 7 is a disquisition on house plants and their care. Chapter 8, Safe Chemicals for the Vegetable Garden, does for the food plants of the garden what previous chapters have done for the ornamentals. Chapter 9, Garden Miracles, recounts some of the scientific discoveries on growth regulators, systemic insecticides, chromosome doublers, etc., in a restrained but inspirational tone. There are still plant worlds to conquer.

Part II of the book (121 pp.) consists of five hundred questions and answers covering typical problems posed to the professional plantsman. The author comes out very well in this "Information, Please" section and conducts his clinic—*in absentia,* to be sure—very skillfully. Every possible query seems to be covered except the one dealing with those spots that come on the underside of fern leaves! The exhaustive index (33 pp.) puts this treasure trove of garden facts at the reader's disposal.

All in all, the author has done a good job. In plant physiology he has not departed from his text that "a well-balanced and adequate supply of soil-nutrients will go a long ways towards guaranteeing success in growing crops;" in pest control he has not been dazzled by new chemical creations. Instead, he has screened these complicated stuffs and their alluring prospectuses, retaining those that under controlled tests have given satisfactory performances. The reader is warned that the avowed purpose of this book is to make the proper use of the proper material in each situation a habit of the home gardener. It may also make home gardening a habit.

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EDUCATIONAL TELEVISION

Today's Science and You. Lynn Poole. 208 pp. Illus. $2.75. McGraw-Hill, New York. 1952.

LET'S see now, for those of you who have television sets this book won't need much of a review. For it transfers to words and pen-and-ink sketches some of the content of those Johns Hopkins TV Science Reviews that the author has produced so successfully. The sixteen chapters of the book have some of the quality of a television show. They hit the high points, and they interest and intrigue, getting across some of the principles involved with simplified analogies.

The story of X-ray is primarily that of applying television to the making of X-ray diagnoses by doctors in different cities who consult, not in person, but by means of television. Similarly, the television camera peers into the electron microscope.

Various chapters tell how rockets have brought back to earth information about the upper atmosphere, how diffraction gratings are made and used, the importance of keeping water free of industrial pollution, the investigation and dangers of the snail-borne disease schistosomiasis, investigation of houseflies, the application of engineering to such common things as automobile dashboards and traffic signs, composition and use of the atomic varieties known as isotopes, the importance of

very small amounts of chemical elements necessary for the growth of plants and animals, the problem of a mysterious disease of cattle, the "illness" of bronze which plagues art museums, a discussion of science in art, an insight into how radioactive carbon gives us the key to the age of past relics, and a concluding chapter looking into the future.

Altogether this should be an interesting book for young people who want to know a little more about the things they have seen on the television screen.

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KEY TO THE PAST

Radiocarbon Dating. Willard F. Libby. vii + 124 pp. Illus. $3.50. University of Chicago Press, Chicago. 1952.

ONE of the most significant discoveries of the past decade was of the existence of measurable amounts of carbon 14 in nature and its use as a method of absolute age determination. This achievement presents an excellent case history of the scientific method in action. Previous data on cosmic ray flux and neutron reaction permitted W. F. Libby to calculate the concentration of natural radiocarbon. This concentration was below that readily measurable with existing techniques, but with ingenuity and perseverance the necessary techniques were developed to test the theory. Within the limits of experimental error the data checked the theory, and the method of dating geological and archeological objects for the recent geological past was made available.

Radiocarbon Dating contains an account of the method as developed in Professor Libby's laboratories at the University of Chicago. The book is clearly and tersely written, giving all the necessary principles and procedures for either the archeologist or geologist who wishes to interpret the results of the method, or for others who wish to set up the technique in their own laboratories. After a summary of the principles involved, the world-wide distribution of radiocarbon, the half-life data on carbon 14, and the details of the sample preparation and measurement are discussed. A list of all of the data obtained in the Chicago laboratory up to September 1, 1951, is given, with brief description of the samples. The book is concluded by a chapter on the significance of these dates, contributed by Frederick Johnson. The paper, printing, and binding are all of fine quality, and errors are practically nonexistent.

Since scientists in many fields are interested in the carbon 14 dating method, and since most of the literature is scattered through several journals, this book is a welcome compilation. It should be noted, however, that this field is developing with extreme rapidity. At the date the manuscript for the book was completed one other laboratory (Columbia) had already been in full operation for several months; now there are two more (Michigan and Yale), and several other laboratories are under construction. There have been almost as many additional samples dated as those reported in the book. The advances in technique are also proceeding rapidly, so that a number of problems noted in *Radiocarbon Dating* have been either solved or simplified. For example, at Columbia alone, the method has been extended to 30,000 years, it has been found that shell is generally useful, deep-sea water has been dated, the leaching process has been speeded up by a factor of ten, and samples as small as 0.5 g have been successfully measured. This situation is inevitable following an important discovery. *Radiocarbon Dating* is complete up to its date of writing, however, and is written with the authority of the scientist who developed the method. It is an indispensable volume for anyone seriously interested in historical science.

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BODY, MIND, AND IMAGINATION

Man on his Nature. The Gifford Lectures, Edinburgh, 1937–38. (2nd ed.) Sir Charles Sherrington. 300 pp. $6.00. Illus. Cambridge University Press, New York. 1951.

NOW Sherrington is dead, and science, particularly his own science of biology, is vastly poorer. It is poorer, not in fact because he will contribute no longer to the discovery of physiological facts about the human nervous system, for there are others who will do that; but rather because that far-ranging, humanistic mind and poetic insight and skill in expression will no longer illuminate Man and Nature. These qualities are so rare in the scientist that Sherrington was truly unique.

It is above all in *Man on his Nature* that these gifts attained their supreme expression. Here the lyrical joy of the scientist in the exposition of his science, the philosophical temper with which the brain physiologist faces the problem of mind and matter, and the fervent warmth with which the evolutionist views the leadership of man on his own planet are fused into all-embracing harmony, into a natural religion that entertains values and harnesses the emotions in the generation of altruism. "We have," says Sherrington, "because human, an inalienable prerogative of responsibility which we cannot devolve, no, not as once was thought, even upon the stars. We can share it only with each other."

Admirers of *Man on his Nature* will be glad that Sherrington did not greatly change the book in preparing the second edition. What he did, what writers so rarely have the courage to do, was to shorten, rather than lengthen it. Skillfully he pruned away the excess, or substituted a more direct treatment for the devious. Nothing essential has been lost, only now the thought mounts steadily to the magnificent climax of the final chapter, the peroration of Nature to Man:

> You are my child. Do not expect me to love you. How can I love—I who am blind necessity? I cannot love, neither can I hate. But now that I have brought forth you and your kind, remember you are a new world unto yourselves, a world which contains in virtue of you, love and hate, and reason and madness, the moral and immoral,

and good and evil. It is for you to love where love can be felt. That is, to love one another.

Bethink you too that perhaps in knowing me you do but know the instrument of a Purpose, the tool of a Hand too large for your sight as now to compass. Try then to teach your sight to grow.

BENTLEY GLASS

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DEEP-SEA FISH

The Ceratioid Fishes: Ontogeny, Taxonomy, Distribution and Biology. E. Bertelsen. Dana Report No. 39. 276 pp. Illus. £2 10s. (50 Danish Kr.). Andr. Fed. Høst & Son, Copenhagen. 1951.

THIS is the most elaborate report on the ceratioid fishes yet published. It is a masterly treatment of a difficult group previously known from about 650 specimens in the museums of the world, 392 of which came from the "Dana" Collections. The present work includes in addition about 2400 larval and about 100 metamorphosing or metamorphosed males. The principal aim of the report was to "increase our knowledge of the uncommonly extensive specialization of these fishes and its relations to the special conditions in the depths of the ocean." As far as the material available permits, the author has got out of it about the maximum information possible.

The section on Ontogeny and Taxonomy occupies pages 7–196, and part 2, Distribution, Ecology and Biology, pages 197–251. A summary occurs on pages 252–257, and the remainder of the report is occupied with a bibliography and tables.

Increased knowledge and identifications of the free-living males, which were placed previously in genera apart from the females, have reduced the number of families to 10 and the number of genera from 46 to 34; 17 genera being discarded and 5 new ones erected, 3 of the 34 genera are based on males not yet identified with females. In all, 119 species are recognized.

Adult ceratioids live at depths where temperature and light have no annual rhythm, yet they have a spawning season determined by the time of year, which for the majority of the species is early summer. The larvae of the summer-spawning species occur mostly at depths of 30–200 meters. Metamorphosis leads to rapid sinking to great depths from 1500 to 2500 meters, or deeper.

The largest ceratioid known is a female specimen of *Ceratias holboelli*, 119 cm total length, or 68 cm without caudal fin. The largest *Himantolophus* is 60 cm; the largest *Cryptopsaras* is 44 cm, and a few other specimens 20 cm and shorter are known; the great majority of species are 5–10 cm. The largest known free-living male, 46 mm, is in the genus *Himantolophus*.

During and after metamorphosis the females become an effective fishing apparatus; the booty, mostly fish and shrimp, are attracted by the light-organ on the illicium (fishing pole) and are then swept by the strong inflow of water into the enormous mouth.

The males, during and after metamorphosis, are adapted to search for females; their swimming power increases, eyes and olfactory organs develop, and their jaws change from a fishing to an attachment apparatus. The illicium and light organs do not develop. Attached males have been found in 4 families: Caulophrynidae, Ceratiidae, Neoceratiidae, and Linophrynidae. In *C. holboelli* there is a vascular connection between the female and the parasitic male, the latter receiving bountiful nourishment for further growth and maturity.

It is probable that the free-living males of the Himantolophidae, Melanocetidae, Oneirodidae, and Gigantactinidae only attach themselves to females during the spawning season and probably are not parasitic.

Although the author, in a very professional manner, greatly extends the knowledge of the deep-sea ceratioid fishes, as he clearly points out, there is still more to learn about this remarkable group of fishes. Dr. Bertelsen's report is an excellent contribution to the science of ichthyology.

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SECOND LOOK

Life in a Mexican Village: Tepoztlán Restudied. Oscar Lewis. xxvii + 512 pp. Illus. $5.00. University of Illinois Press, Urbana. 1951.

THE reader of Lewis' book gets a double dividend: first, an acute analysis of social relations in a Mexican town; second, a critical appraisal of the findings and methodology of another anthropologist, Robert Redfield, who studied the same town twenty years earlier. Rarely have village studies been systematically rechecked in this way. Reports on primitive tribes have generally been defective in method, but since few other social scientists went to such out-of-the-way places, they have been naïvely accepted as accurate. Now that the anthropologist, whose primitives are ceasing to be primitive, is staving off technological unemployment by studying civilized communities, his lack of training in techniques applicable to those communities is proving a handicap.

What, then, does Lewis find? Although sympathetic with Redfield and not inclined to exaggerate discrepancies, he nevertheless finds what appear to be many errors, some of them small but others profound. For instance, Redfield depicts Tepoztlán as "a relatively homogeneous, isolated, smoothly functioning, and well-integrated society made up of a contented and well-adjusted people."

He glosses lightly over evidence of violence, disruption, cruelty, disease, suffering, and maladjustment. We are told little of poverty, economic problems, or political schisms. Throughout his study we find an emphasis upon the cooperative and unifying factors in Tepoztecan society. Our findings, on the other hand, would emphasize the underlying individualism of Tepoztecan institutions and character, the lack of cooperation, the tensions between villages within the municipio, the schisms within

the village, and the pervading quality of fear, envy, and distrust in inter-personal relations.

Redfield stresses the communal lands of the village; actually, the communal lands are the worst and are worked by inefficient hoe agriculture, whereas the private holdings comprise most of the level land worked by plow agriculture. Furthermore, the communal lands are all individually, not communally, operated. Redfield says there is collective labor in the village, but Lewis finds this has not been part of the system since before the Revolution and, when it was in existence under Diaz, it had more the character of forced labor than of voluntary cooperation. Also, the communal lands have been a source of severe conflict within the *municipio*, resulting in violence during the very year that Redfield was in the village.

Redfield portrayed the village as a community of landowners, but Lewis finds that over half the villagers own no private land at all. "Redfield did not mention the existence of a land problem or land shortage in Tepoztlán," whereas one of the crucial problems, according to Lewis, is "the rapid increase of population with no accompanying increase in resources or improvement in production techniques." In addition,

Redfield gave a rather glowing picture of Tepoztlán during the Diaz regime as having reached a period of great cultural florescence, but failed to point out that this was limited to only a few Tepoztecans, and that the vast majority of Tepoztecans were illiterate, desperately poor, landless, and living under an oppressive political regime which forbade them to utilize their own communal resources.

With respect to interpersonal relations, Redfield presented only the positive and formal aspects, omitting the negative and disruptive. "An examination of the local records revealed that in the year that Redfield lived in the village there were 175 reported cases of crimes and misdemeanors in the local court." According to Lewis, Redfield oversimplified and misinterpreted the class structure.

These differences are fundamental. Assuming that Lewis is right (he spent twice as much time in the village, had the assistance of more Mexican personnel, and documented his material more fully), one naturally raises the question, Why the Redfield errors? The two most important explanations are: (1) Redfield's conceptual apparatus—woven around a simple dichotomy between "folk culture" and "urban culture"—was too ambiguous, oversimplified, and value-oriented for the derivation of empirically valid hypotheses. (2) Redfield relied too heavily upon the traditional anthropological use of "informants"—to the neglect of statistical, historical, and economic materials that were available at the time. On certain topics he apparently got his information from only *one* informant who, says Lewis, was regarded in the village as somewhat foolish.

In his work on primitive societies the anthropologist has had to be a jack-of-all-trades. Often the only man reporting on a tribe, he felt obligated to bring back information on everything from pottery styles, clothing, and house-building to kinship patterns, sentiments, and religion. To do a good job he would have had to be an economist, a statistician, a linguist, a psychologist, and many other things as well. The assumption that a civilized or even a peasant community can be fruitfully studied in such an encyclopedic, unfocused way is fallacious. Anthropologists are as ignorant of economics, statistics, demography, social psychology, and history as others who have not specialized in these fields.

By trying to get beyond some of the limitations of his field, Lewis has done an interesting job; but he occasionally misses opportunities because, being only one man, his acquaintance with certain areas of knowledge is slight. For example, although he advisedly gives more population analysis than anthropologists usually attempt, no demographer would be entirely satisfied with his handling of the data. The same is probably true with respect to the economics and agriculture sections. The marvel is that he has handled as well as he has such a wide range of topics. He has done fairly well what could have been better done by a team of experts.

His analysis is more sure-footed and rewarding when dealing with interpersonal relations within the community, especially with reference to the family. In this realm, the main focus of the book, he turns in a superb performance. Although studies of one town or village cannot tell us much about a whole country, they nevertheless give us a certain kind of insight that country-wide analyses cannot give. The present book is one of the best examples of what can be accomplished in a village study.

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MAN AND NATURE IN THE TROPICS

Where Winter Never Comes. Marston Bates. 310 pp. Illus. $3.50. Scribner's, New York. 1952.

THIS comprehensive study of the tropics of the world, with the basic idea that they are a wonderful place to live, gets off to a slow start but increases in fascination with each turning page. Beginning with Chapter 3, where the first touch of humor and personal philosophy appears, the book shows that Western man should leave at home his "white man's burden" of heavy clothes and other similar impedimenta of civilization when he goes to the regions south of the Tropic of Cancer and north of Capricorn.

Dr. Bates' purpose is to describe "the characteristics of men and nature in the tropical environment," to "examine this business of climate and civilization," to "make a contribution toward neighborhood understanding." Although he covers the globe, his emphasis is upon the Caribbean, where much of his own work with the Rockefeller Foundation has been done.

There is a chapter of history, of tropical exploration, at the beginning of the work. There is a chapter on the various varieties of tropical government near the end. In between are considered studies of anthropology and

paleontology, of human evolution—"almost the whole known range of human racial variation is found in . . . this tropical zone"—of tropical culture, and of the origin of agriculture. If "we surveyed the world a thousand years ago, we would find much of man's greatest achievements within the tropics."

The study of tropical climate, of tropical diseases—malaria is "probably the most important single disease afflicting mankind"—of foods such as rice, coffee, and the extraordinary variety of fruits, and of the peculiar plants, mammals, insects, birds, and snakes, leads to the outstanding section of the book.

Dr. Bates surpasses himself in his chapters on the rain forest: "Apparently conditions in the forest are so favorable that almost anything can survive, and almost everything does." He concludes with the plea that we "go to the tropics as students, to learn what we can there of nature and of man. For certainly there is much to learn." And in reading his book about the tropics there is informative pleasure.

MARJORIE B. SNYDER

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MYCOLOGY

The Molds and Man. An Introduction to the Fungi. Clyde M. Christensen. viii + 244 pp. Illus. $4.00. University of Minnesota Press, Minneapolis. 1951.

A GROUP of philosophers, scientists, and statesmen was discussing Voltaire, after meeting with him, and expressed amazement at his knowledge. Each man, however, thought that his own particular field was the one in which Voltaire was weakest. This is just the way I feel about Dr. Christensen's book: a very good book, but somewhat weak in the treatment of those parts of mycology with which I am most familiar.

After two chapters, designed to give an idea of what fungi are and do, the reader is taken into the fascinating world, of which many people are unaware, formed by the nonparasitic relationship between fungi and other organisms.

The next two chapters are devoted to the study of fungi as plant parasites. The section on rusts and smuts is very good, and it gives the reader an idea of the difficulties encountered in breeding varieties of wheat resistant to the encroaching rust. The author has avoided the beaten path and, if I am not mistaken, does not even mention the discovery of the Bordeaux mixture. Instead he gives an interesting account of Prévost's discovery of the fungicidal action of copper and copper salts.

Chapter 7, on Fungi that Destroy Commercial Products, leaves one in the frame of mind of the medical student who begins to imagine he has all the symptoms of the diseases he is studying. You will catch yourself examining your food, shirt, and shoes with suspicion.

Chapters 8 and 9 deal with fungi as animal parasites. The life history of the fungi that trap nematodes is so intriguing, and Dr. Christensen's account so lively, that I made a mental note to have a look at these reticulated organisms in action, before I die. A discussion of the use of fungi in the biological warfare against certain insects led the author to these words of wisdom concerning our own future safety (p. 165):

> That our crops, domestic animals, and even we ourselves might suffer fairly heavily from the introduction of destructive bacteria, molds, insects, or other enemies is a possibility that we must recognize. But that we are likely to be wiped from the face of the earth by such means is certainly a very remote possibility.

Fungi Exploited Industrially is the title of the last chapter. It contains a good account of the fungi that are responsible for some of the cheeses we eat, and an interesting section on the cultivation of mushrooms. Christensen does not seem to be familiar with the production and extraction of natural products, and accordingly the section on the production of drugs by fungi is weak. This is also the reason why the author seems to think that the story of streptomycin has been cloaked in mystery. This mystery exists only in his mind, and could easily be cleared up.

The book ends with an appendix, Summary of the Classification of Fungi. These 26 pages will be useless to both the specialist and the layman. The specialist already knows what is there, and the layman will not find it easy to follow the text, which is not illustrated and contains technical terms that are not always explained. I refer Dr. Christensen to the chapter on fungi in Gulliermond and Mangenot's *Biologie Végétale* (Masson, 1946) if he wants to find out how such a chapter might have been written and illustrated.

It is not easy to write a book for the layman, and on the whole, Christensen has done very well. If you are not familiar with mycology you cannot expect to understand everything in *The Molds and Man*; a glossary would have been helpful. The book would also gain a lot if it were more abundantly illustrated. It is hoped that author and publisher may be able to make, from a good book, a better book, in the next edition.

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SCIENCE REVIEWED

Profile of Science. Ritchie Calder. 326 pp. $3.75. George Allen & Unwin, London (1951); Macmillan, New York. 1952.

Panorama of Science, 1951. Annual Supplement to the Smithsonian Series for 1951. Compiled and edited by Webster Prentiss True. ix + 416 pp. Illus. $5.50. Series Publishers, New York. 1951.

THESE two books represent totally different trends in presenting science to the general reader. One is an attempt to show the nature of modern science by considering achievements in four areas; the other is a compilation of articles written by experts and representing the major fields of scientific inquiry.

Mr. Calder, science editor of the British *News Chronicle* and United Kingdom delegate to Unesco, has chosen nuclear physics, electronics, penicillin, and vitamins as

his four topics, and each is written up in terms of a central figure of his personal acquaintance: Rutherford, Watson-Watt, Fleming, and Hopkins, with Lord Boyd Orr added at the end "as the embodiment of the social-purpose of science." One of the most engaging aspects of Calder's book is the skill with which he presents many of the leading figures in modern science as human beings and their work as an understandable creative action, rather than cloaking the development of modern science in "mystery" and "miracle" and the scientist in the impenetrable garb of "genius."

Whereas Calder has written for the "average man" with little background in science, Mr. True has selected an audience on a somewhat higher level. I suspect that readers of The Scientific Monthly may find Calder's book, therefore, a little too much given to household similes; thus the Meitner-Frisch theory of the nucleus is described as follows: "The uranium nucleus is like an unhappy home in which husband and wife are constantly squabbling . . ." and so on. It is a pity that this device is used so often, to mar what is otherwise an interesting and reasonably accurate account of some major aspects of modern scientific research. All readers will, however, be interested in the many firsthand anecdotes, which serve at once to render the scientists in the book more human and to document that little-explored subject of the relations of scientists with the press as mediators between them and the general public.

Mr. True, formerly chief of the Editorial Division of the Smithsonian Institution, has gathered 27 excellent articles and reprinted them in his work, which is the first of a series of annual volumes. Each article has been published previously and is a well-written account of the subject; the theory behind the volume is that the "only sure method of presenting for thoughtful readers an authentic picture of science progress is to let the scientists speak for themselves." Many readers might have thought of articles other than those chosen by Mr. True, but I doubt if anyone will find that the articles he has included are not of first quality. The subjects covered are astronomy, rockets and space flight, applied nuclear physics, general physics, metallurgy, geology, anthropology, zoology, botany, archaeology, geology, geography, medicine, and technology.

Each selection is introduced by a short paragraph in which the editor states the main outlines of the problem under discussion and the author's treatment of it. In almost every case, but for some reason not all, the author is identified; the source of each article is given. It should be noted that this book is not an attempt to present the major advances in science in 1951, nor to cover every field (psychology and mathematics, for example, are not represented). The book is rather an anthology of some of the best writing in science for 1951, and as such it provides absorbing reading on a level that will be intelligible to readers of The Scientific Monthly and that will convey accurate information. All who read this volume will wish the series a successful career.

I. Bernard Cohen

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DIET AND WEATHER

Nutrition and Climatic Stress. (With Particular Reference to Man.) H. H. Mitchell and Marjorie Edman. xii + 234 pp. Illus. $6.75. Thomas, Springfield, Ill. 1951.

A REALISTIC review of this work must first point out the sharp limitation of its contents and its failure to meet adequately the broad connotations of its title. The opening sentence of its preface supplies the key to its motivation and coverage of the subject: "The material contained in this monograph was prepared originally under a contract between the University of Illinois and the Quartermaster Food and Container Institute for the Armed Forces. . . ." In line with this motivation, the volume essentially comprises a laconic survey of work (part published and part in "restricted" files) carried out by or supported by governmental and military agencies since the start of World War II. In essence it represents the University of Illinois Department of Animal Nutrition authors' postwar summarization (for military files) of the war effort in this particular field.

Even as a survey of published literature, it fails to live up to its title. It greatly overemphasizes investigations carried on during the war and postwar years, to the neglect of much of the earlier work of great basic importance in the stated field. Even a cursory analysis of its 60 pages of "Literature Cited" provides adequate substantiation for the above statements.

The monograph contains 174 pages of textual material (including tables and illustrations) and 60 pages of literature references. These 60 pages of "Literature Cited" contain a total of 838 individual citations, 604 to publications or "restricted" reports in the decade 1940–49, 168 in the decade 1930–39, 52 from 1920 to 1929, and only 14 in the years before 1920. Most investigators at all familiar with this general field will realize the unbalanced character of any such survey. As one closely identified for the past several decades with this field of research, the author of this review notes that reference is made to 8 of his publications in the 1940–49 decade but none to the twoscore or more pertinent articles he published in previous decades.

Having thus delineated the monograph's restricted scope and inadequate coverage of its titular implications, the reviewer would now point out that the material is well organized into its few main headings and numerous subheadings, and is well indexed. Diet in a Cold Environment, Diet in a Hot Environment, Diet at Altitude, and Practical Considerations form the book's appropriate and descriptive chapter headings.

A few of the monograph's points of information of more general interest are (1) that climatic stress sharply modifies the body's caloric requirements (both at rest and in activity) to meet varying rates of body heat loss, (2) that water and salt needs are severely affected under such difficulties in heat loss as are experienced in desert and other types of hot environment, (3) that fatty and carbohydrate foods are more helpful than protein

in severe cold, (4) that carbohydrates are best tolerated by those exposed to high altitudes, and (5) that thiamine is helpful in severe heat. The writer of this review would take issue with several interpretative statements, but not in the space assigned him here.

As a physical production job, the book shows the meticulous attention to quality and technique characteristic of Thomas books. Not a single typographical error was noted by the reviewer in his careful perusal of the monograph.

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BRIEFLY REVIEWED

American Weasels. E. Raymond Hall. 466 pp. + 41 plates. Offered on an exchange basis. University of Kansas Publications, Museum of Natural History, Lawrence, 1951.

AMERICAN WEASELS is as comprehensive and precise as its title. With characteristic thoroughness Dr. Hall has examined and described in detail an enormous quantity of material, recent, fossil, and Old World, and culled from the literature on the subject a great deal of pertinent and interesting information. With equally characteristic precision, he has put down not only his own conclusions, but the details of color, form, or recorded history that are the basis for his opinions.

Primarily Dr. Hall is a taxonomist, with a taxonomist's preoccupation with physical variation, whatever its significance. It is this concern which seems to be the point of focus for his work and makes the initial eighty-odd pages of interest to more than the specialist in weasels. In this section, together with a careful account of the structure, relationships, and paleontological history of weasels, he describes their age, sex, seasonal, and individual differences. This leads naturally into a discussion of specific and subspecific characters. Here the reader will find well demonstrated, though not specifically expounded as such, the taxonomic methods and philosophy of one of our most active teachers and mammalogists. Of even wider interest are his related comments on distribution, and the relation of geographic area and climate to variation.

The remaining, and by far the greater part of the book, is devoted to an exhaustive discussion of the forms recognized. This follows an exact and regular pattern. The condition of the type is discussed, the range is given, and "characters for easy recognition." Then come more detailed descriptions, those of the color presumably based on the whole series studied, those of the skull on selected series. Considerable space is also devoted to such subjects as intergradation, variation within subspecies, and taxonomic history. Notes on natural history, largely in the form of direct quotations from a variety of sources, are included in the introductory account to each of the four species recognized. Although there is a key to species, identification of subspecies depends on the descriptive text with its careful comparison of adjacent and related forms. Tables of measurements of selected specimens, distribution maps, a large series of skull photographs, and an excellent bibliography should also be mentioned.

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Mosquitoes of the Ethiopian Region. I. *Larval Bionomics of Mosquitoes and Taxonomy of Culicine Larvae.* (2nd ed.) G. H. E. Hopkins. viii + 355 pp. Illus. £2 5*s.* British Museum (Natural History), London. 1952.

THE first edition of this work was published in 1936, and since that time the active work in this family has resulted in the addition of 86 species to the fauna, as well as the discovery of the larval forms of a number of the previously known species. The size of the volume has increased by 105 pages, and 53 illustrations have been added. The first thirty pages of the book deal with the natural history, external anatomy, and the techniques of collecting, rearing, identifying, and preserving larvae. The remainder of the book is taxonomic, giving keys to the known larvae, followed by descriptions, illustrations, and a brief statement concerning the breeding places. Species for which the larvae are unknown are listed with a note on the probable breeding places, which should serve as a great stimulus for further collecting.

Since there are still a considerable number of species for which the larvae are unknown, as well as a number of species yet to be described, this edition will likewise become out of date as the years go by, but for the present it is of great service to anyone wishing to identify culicine mosquito larvae from tropical Africa.

ALAN STONE
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Factors Regulating Blood Pressure. Transactions of the Fifth Conference, February 15–16, 1951, New York. 238 pp. $3.75. Benjamin W. Zweifach and Ephraim Shorr, Eds. Josiah Macy, Jr. Foundation, New York. 1951.

TO COMMUNICATE the informal give-and-take of a panel discussion to an anonymous reader remote from the field is an editorial task of no mean magnitude. Such a reader can catch only a dim reflection of the light generated at such a meeting. He misses much, such as the tone of the voice, the expression of the face, the intuitive evaluation of a personality. When the fruits of these conferences are recorded verbatim, as they are in this series, these qualities cannot be transmitted, and as a consequence the transcript may very well read like something out of the *Congressional Record.*

In spite of these handicaps, the editors of this volume have succeeded in bringing to us a stimulating and pro-

vocative compilation of the results of the Fifth Conference, on factors regulating blood pressure, sponsored by the Josiah Macy, Jr. Foundation. The conferences are designed to bring together men from different scientific disciplines working on the same general problem, in the hope that the artificial barriers tending to separate and fragment science will be breached. A careful reading of this book will repay anyone interested in the subject under discussion, provided he has a good background in the field. It is definitely not recommended for the general or casual reader. Whether the editors would have violated their trust by inserting a short and carefully worded summary of the viewpoints presented is a matter that should be decided elsewhere, but there can be no question that such a summary would be of great value to any reader.

The participants are a distinguished group of investigators, representing all fields of medicine. The subjects discussed can be roughly grouped under the headings of atherosclerosis, arteriosclerosis, and experimental renal hypertension, with the emphasis on the role of lipid metabolism, and specifically cholesterol metabolism, on the etiology of atherosclerosis. The presentations are all extremely competent, and the implications of the work are highly exciting. Not the least of these may be best summed up in the words of L. N. Katz, who stated that atherosclerosis may be considered as a "pathologic process distinct from (although often accompanying) aging" and "that it is not inevitable." The sociological inferences of such a statement are rather staggering and were not explored by the conference. Another thought-provoking finding presented to the group was the data on the incidence of deaths from circulatory disturbances and the consumption of fat in Norway during the war years.

The volume is well prepared, well illustrated and, most important of all, well indexed. It is earnestly recommended to all physiologists, pathologists, and clinicians concerned either with the study or the treatment of diseases of the heart and blood vessels.

DIETRICH C. SMITH

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Trauma, Growth and Personality. Phyllis Greenacre. xii + 328 pp. $4.50. Norton, New York. 1952.

THE author of this book is professor of clinical psychiatry and a well-known practicing New York psychoanalyst of the Freudian school. The latter gives the book the imprint. Anyone not sufficiently familiar with Freudian concepts or who does not accept his theory of sexual development will be disappointed in the book.

According to the author, "There are many areas of early personality development which have not been investigated or where the investigation has been along certain lines, undoubtedly representing special traumas in the first few years of life and the probable effect of these early patterns on the structure of the later personality."

The book is a collection of fourteen chapters, thirteen of which have appeared as contributions to various journals. For the practical scientist the outlook seems too narrow to explain the constitutional plus environmental plus creative factors of normal personality development ("total personality" of A. Meyer). After all, not all our fellow-men carry a neurotic or anxiety-laden personality within them.

Extensive references cover all chapters. As a whole the book will be of interest to all students of science who are investigating the various aspects of personality development.

PAUL WENGER

Peeksville, New York

The British Pharmaceutical Codex 1949. Supplement 1952. Codex Revision Committee; C. W. Maplethorpe, Chairman. 148 pp. 25*s*. Pharmaceutical Press, London. 1952.

THE Council of the Pharmaceutical Society of Great Britain reappointed the Codex Revision Committee in February 1950 to amend and revise the *British Pharmaceutical Codex 1949.* The committee decided to prepare a *Supplement* to include monographs on drugs recently introduced into medicine for which clinical evidence of effectiveness was considered adequate but which were not included in the *British Pharmacopoeia,* the *British Pharmaceutical Codex,* or in the *Addendum to the British Pharmacopoeia.* The *Supplement* also contains information on the action and uses of drugs added to the *British Pharmacopoeia* by the *Addendum* and not previously described in the *British Pharmaceutical Codex.*

The *Supplement* contains amended monographs where experience with the tests and assays specified in the *British Pharmaceutical Codex* has indicated that such amendments were desirable. In Part I of the *Supplement* there are 36 new monographs; of these, 14 relate to substances added to the *British Pharmacopoeia* by the *Addendum* in 1951 and not previously described in the *British Pharmaceutical Codex.* Twenty-two are for substances not previously described in the *British Pharmacopoeia,* and monographs for 14 substances for which standards were specified have been suitably amended. New monographs for such important substances as amidone hydrochloride, aureomycin hydrochloride, benzylpenicillin, chloramphenicol, dihydrostreptomycin, procaine benzylpenicillin, propylthiouracil, streptomycin hydrochloride, and tubocurarine chloride are included. Many corrections and additions to tests and assays and changes in formulas are introduced.

The book is a valuable reference for all individuals dealing with formulation of pharmaceutical products and standards for drugs. It is particularly valuable for those who manufacture, prepare, and distribute drugs in areas where the products must conform to the laws of Great Britain.

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LETTERS

TEACHING SUCCESS VS. RESEARCH ABILITY

I SHOULD like to take strong exception to the statement by Professor Lindsay in his otherwise fine article in the March 1952 issue of THE SCIENTIFIC MONTHLY —namely, ". . . We here assume that the most successful teachers are those whose research ability justifies partial support of their budgets through research contracts. This will hardly be disputed by most physicists." In the absence of statistical evidence correlating teaching success and research ability, it appears to me that Lindsay has made unjustifiable extrapolation from research ability to teaching success. It may be that he has been out of the student's role too long. As a result of my very recent occupation of this role in a large and reputable physics department, I have reached the tentative conclusion (and the great majority of my fellow-students appeared to concur) that no correlation exists between success as a teacher and research ability. Since the two types of endeavor under consideration require essentially different attributes, I can find no a priori reason for expecting a high correlation between them.

The art of successful teaching requires an ability in the effective imparting of knowledge already acquired by him who teaches. The teacher must project himself into the student's mind. He must foresee the pitfalls into which the student might fall, and after selecting those into which he will let the student fall for pedagogical reasons and carefully skirting the rest, he must make the student aware of the latter's existence. This is not to say, however, that he must spoon-feed the student. The dangers of this procedure are apparent, I am sure, to everyone.

The successful researcher, on the other hand, must have mastered the esoteric techniques of his own branch of science and must in addition be endowed with creative ability. He usually requires strong motivation and perseverance to sustain him on the journey over the often tortuous paths in which scientific research seems to lead the investigator.

We note here that both the teacher and the researcher require great technical knowledge, but that the former needs an outwardly directed approach and an ability for transmitting his knowledge, whereas the latter usually must direct himself inward and exercise an ability for synthesis and creativity. Although both sets of abilities *may* exist in the same individual, we must recognize that as the individual shifts from his research to his teaching he shifts from the use of one of these sets to the other in the successful performance of the role of the moment. At the advanced level where the student is learning by performing research with, or under the direction of, a mature investigator, we must differentiate between the actively self-propelled learning of the student, which frequently exists even in the absence of good teaching, and teaching directed at the student. It appears that many excellent researchers merely form nuclei around which students can gather to learn what they can. In some cases it would even seem that the student learns despite the teacher. In far too many cases the teacher is a hindrance to the student by virtue of the confusion he spreads. (The confusion, in the event that the would-be teacher is an able researcher, is not necessarily a manifestation of confusion in the mind of the researcher-teacher, but rather of his inability to understand the student's mind.)

As an illustration taken from the physics faculty of the university at which I recently took my Ph.D. I have prepared Table 1, in which an attempt has been made to grade the various members with regard to both research ability and success as teachers. The latter refers to both classroom teaching and thesis direction. Grades are based on the A, B, C, D, F system. The ratings are from my personal experience or have been given to me by fellow-students closer to the teacher-researcher in question. In those cases in which no information was available to the present writer, no grade has been given.

TABLE 1

PROFESSOR	ABILITY AS RESEARCHER	SUCCESS AS TEACHER: Classroom	SUCCESS AS TEACHER: Thesis-Teaching
1	A	B	—
2	C +	B	B
3	C	F	—
4	B	D	C +
5	B	F	—
6	A +	D	D
7	A +	B +	A
8	B	D	B
9	A +	A	—
10	A +	B +	—
11	A –	C	B
12	A –	A	A
13	B –	C	C

We observe that, as is frequently the case, the faculty is composed of excellent research physicists. (After all, is it not upon research publications that promotions are based!) The average research ability grade is B +. Casual observation reveals that of the thirteen faculty members listed, only two are better teachers than physicists, whereas eleven are better physicists than teachers. We also note that although seven were between A – and A+ in research ability, only two of these made A's in the classroom teaching. Probably the most appalling feature is the presence of two F's and three D's in classroom teaching, coupled with the fact that four of these five faculty members were rated B or A in research ability.

Obviously, we must not attempt to push these qualitative estimates and limited numbers too far, nor is the influence of personal bias to be completely discounted. Also, no conscious account has been taken of motivation,

although if Professor Lindsay really meant to correlate research *ability* with *success* in teaching the motivation or interest factor is tacitly included.

I hope these remarks will not be taken as carping, or hair-splitting criticism of Lindsay's statement. It is rather my intent to focus attention upon a widespread and, as it appears to me from my limited experience, unjustified belief.

NAME WITHHELD

THE DUSTY AND STONY ROAD OF CRITICISM

I WAS somewhat appalled at the unidentified commentary, appearing on page 245 of the April number, on the AAAS Editorial Board and "The Emperor's New Clothes," which waxed indignant at the idea of a botanist commenting on the philosophy of education. This is similar to the argument that only ministers, priests, and Doctors of Theology have any right to express an opinion concerning religion, or that only politicians and political science professors should make any comment on abuses of public office.

Education is one of the subjects that concern all the membership of the society; many of them are engaged in it, including the author of the article in question; many of the rest are concerned with the product of the system of education if not with the mechanism of education. Why shouldn't any educator or even any layman express his considered opinion on the subject? And why shouldn't any scientist do so in THE SCIENTIFIC MONTHLY? If education departments are so sensitive to attacks outside of their own departments, they must be singularly vulnerable to such attacks. I think this comment is more condemnatory to education departmentalism than anything said in Fuller's article. Nevertheless, the ironical suggestions of the anonymous critic have much merit I think; e.g., a good critical article by a physicist on the training of psychologists would probably be an excellent thing.

Another point made is of some importance. "You seem as yet to be quite unaware that it is the responsibility of a journal published by the AAAS to give its readers dependable knowledge. After all, THE SCIENTIFIC MONTHLY is presumably not a journal of opinion. . . ." Why shouldn't it be a journal of *scientific* opinion? What, for that matter, is reliable knowledge?

Now that the anonymous critic has been told off, I will take his place. As a reader of THE SCIENTIFIC MONTHLY for some years, off and on, I shall take occasion to protest against, and request the removal of, the occasional "poetry" that finds its way into the pages somehow. This junk is an affront to an intelligent and discriminating reader (and I will be surprised if most of the membership does not agree with me on this).

Yours for more scientific controversy and "venomous attacks,"

F. C. MACKNIGHT

Yingling Oil Operations
Evansville, Indiana

APROPOS of the continuing debate on "The Emperor's New Clothes . . ." (SM, April 1952), I believe you will be interested in the following, which I quote from the preface to Walter S. Campbell's book *Writing: Advice and Devices* (New York: Doubleday, 1950):

At one time I was badly in need of a secretary. An intelligent young woman applied for the job. She was the product of one of those progressive high schools. What projects she had taken up there I cannot tell, but they did not include anything useful.

She could not type because she could not spell. She could not file letters because she had never learned her ABCs. She could not keep books, for she had never heard of the multiplication table. She explained why she could not write a decent sentence or frame a paragraph—because at her school they had ignored grammar and "just studied English"! She knew no shorthand; she said that at school she had always been *too busy with her projects to learn anything.*

Occasionally I meet a would-be writer who reminds me of that would-be secretary.

For self-expression is not equivalent to creation. Spontaneity is the end, not the beginning, of training; we have to learn to walk before we can dance—and even then we have to learn the dance steps. A polo player is never any better than his horse, nor is an artist any better than his craftsmanship. We may all thank heaven that Shakespeare never attended a progressive school.

Try this little piece on the progressive educators who, methinks, protest their innocence much too much.

HAROLD H. STEINOUR

Northbrook, Illinois

THE TYPOGRAPHICAL ERROR IS A SLIPPERY THING AND SLY

I AM sorry that my article entitled "Feed the Soil!" which appeared in the April issue (p. 223), contains a very serious typographical error. In checking my manuscripts, I find that this error occurred in my original copy and that it passed through several revisions, retypings, and proofreading without discovery. I have always been amazed to notice how much more easily errors can be spotted in a printed article than in the manuscript.

The sentence (p. 225) reading "The actual total weight of the invisible living organisms in an acre plow slice of soil is from 10,000 to 50,000 pounds" should read "from 1,000 to 5,000 pounds." Certainly even this amount is impressive enough without unnecessary exaggeration.

F. L. WYND

Department of Botany and Plant Pathology
Michigan State College

OWING to a printer's error, the price of the book by Arthur H. Graves, *Illustrated Guide to Trees and Shrubs,* reviewed on page 242 of the April issue of THE SCIENTIFIC MONTHLY, was erroneously given as \$4.40. The correct price is **\$4.00.**—EDITORS.

ASSOCIATION AFFAIRS

PRELIMINARY ANNOUNCEMENT, SIXTH ST. LOUIS MEETING, DECEMBER 26–31, 1952

THE 119th Meeting of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—the annual meeting for the year 1952—promises to be one of the most significant meetings the Association has ever held. No organization that has grown each year until it now has 232 affiliates and nearly 50,000 individual members could hold an unimportant meeting, but this year certain programs will have especial significance in a time of tension and emergency. Consistent with the prime purposes for which it was founded 104 years ago, the Association's meeting will bring together leaders and younger men and women in every field of science, not only to read papers and discuss their specialties but also to attack some of the problems that affect science and the world today. Several of the programs, and particularly the general symposia, will merit the attention and attendance of all who can possibly journey to St. Louis.

At this year's meeting—which has as its theme "The Common Ground of Science, Mathematics, Engineering, and Industry," and which is officially recognized as the final event of the Centennial of Engineering—it is anticipated that there will be an increased attendance of engineers and industrial scientists meeting with scientists in other fields. At the same time, however, all 18 of the Association's sections and subsections have planned attractive programs of their own, and at least ten sections will have sessions for contributed papers. Some 30 societies have scheduled national meetings or regional sessions with the AAAS. The relative nearness of St. Louis to all large Midwestern institutions assures a good attendance from this great area but, as usual, no section of the United States and Canada will be unrepresented.

The Association will sponsor two general symposia that will equal, or may even surpass, those on "Soviet Science" and "Operation Knowledge" at last year's Philadelphia meeting. The first of these, scheduled for early in the meeting period, is "Disaster Recovery," first proposed by the AAAS Section M Committee, and adopted with enthusiasm by the AAAS Symposium Committee. In scope, its three or four sessions will deal with recovery from disasters of natural origin (floods, hurricanes), from large-scale industrial disasters, and from such disasters as wartime urban fire raids and atomic blasts. National and international authorities will be among the speakers; there will be a serious attempt to assess the common principles of the reactions and recovery of communities; and such aspects as emergency and health measures, law and order, psychology and morale, re-establishment of transport and communications, legal questions (identification of casualties, replacement of records), and rebuilding and city planning will be considered.

The second general symposium, which will comprise two sessions on December 30, will consider latest developments in "The Nation's Nutrition," from "soil to cytoplasm." After an introductory examination of soils from a nutritional point of view, photosynthesis, and plant and animal food products, the larger part of the program will be concerned with the biochemistry of human nutrition, caloric requirements, protein requirements and amino acids, vitamins and trace bio-elements, and food processing and its effects. Howard B. Lewis, chairman of the Department of Biological Chemistry, University of Michigan, is program chairman.

The week's activities will center in the Henry W. Kiel Auditorium, within a few blocks of all downtown hotels. Here will be held the general symposia, some of the mathematical sessions, the sessions of the Oak Ridge Institute of Nuclear Studies, nearly all the sectional programs, the National Geographic Society's Annual Lecture, and the Biologists' Smoker. The physical relationships of the session rooms, the Main Registration, the Visible Directory of Registrants, the AAAS Science Theatre, and the Annual Exposition of Science and Industry, which will fill the Auditorium's Convention Hall, are almost ideal.

Hotels. The Jefferson Hotel will be AAAS Headquarters and will house the engineers and the physical and industrial scientists. It will be the locale of such evening events as the AAAS Presidential Address and Reception, December 28, the Sigma Xi Annual Address, December 29, and the Annual Address of the Scientific Research Society of America, December 30. The Statler will be headquarters for the Society of Systematic Zoology, the Herpetologists League, Alpha Epsilon Delta, and other medical and biological groups, including the botanists and the ecologists. The three science teaching societies, the National Association of Biology Teachers, the National Science Teachers Association, and the American Nature Study Society, will occupy the Hotel De Soto. The American Mathematical Society and the Mathematical Association of America, which are meeting with the AAAS for the first time since 1949, will hold most of their sessions on the campus of Washington University, and will probably be housed in the Forest Park, Kingsway, and Roosevelt hotels. Among other hotels that have pledged sleeping accommodations at moderate rates are the Lennox, Mark Twain, and Mayfair (all convenient to the De Soto, Jefferson, Statler, and the Kiel Auditorium). Housing information and coupons for room reservations will appear in SCIENCE and THE SCIENTIFIC MONTHLY beginning about the end of July.

Advance registration. As in recent years, advance registrants will receive the General Program early in December by first-class mail. Coupons will appear in

the AAAS journals, beginning in late July. This year, the General Program will be simplified in format, its directory content will be increased, and, in response to an increasing demand, it will be made available to others not planning to attend the 119th meeting.

THE PROGRAMS

A—Mathematics

The *American Mathematical Society,* holding its national meeting with the AAAS, will have some 17 sessions for short contributed papers, three invited addresses, a business meeting, and a banquet. President J. Von Neumann will deliver his retiring address, and the Gibbs Lecture will be given by Marston Morse; both are in the Institute for Advanced Study. The national meeting of the *Mathematical Association of America* will have sessions on December 30. The vice-presidential address of the chairman of *AAAS Section A* will be given by R. L. Wilder, University of Michigan.

B—Physics

The *American Meteorological Society,* which will hold its 119th meeting with the AAAS, plans a number of sessions for contributed papers. The *Oak Ridge Institute of Nuclear Studies* will have two symposia: "Use of Radioisotopes in Industry," which will be cosponsored by Section B; and "Research Applications of Carbon 14;" ORINS will sponsor a luncheon the same day. The *St. Louis University Institute of Geophysics,* the American Meteorological Society, and the *American Geophysical Union* will cosponsor one or more symposia in geophysics (meteorology, seismology, hydrology). *AAAS Section B,* in addition to its cosponsorship of the radioisotopes symposium, will have a symposium on "Magnetic Resonance and its Applications;" at the physicists' dinner, Arthur H. Compton, Chancellor of Washington University, will give the vice-presidential address.

C—Chemistry

AAAS Section C has allotted two days for contributed papers in the principal fields of chemistry and the remaining four days for a series of symposia on medical and industrial chemistry.

D—Astronomy

The *American Astronomical Society* has not yet decided on its national meeting plans for 1952. The program of *AAAS Section D,* however, will include at least one technical symposium and a vice-presidential address by Harold L. Alden, Leander McCormick Observatory, University of Virginia.

E—Geology and Geography

The *Geological Society of America* and *AAAS Section E* will cosponsor sessions for contributed papers in general geology; a two-session symposium on "Modern Research of the State Geological Surveys and its Economic Values." This program of six papers by as many state geologists, with six planned discussions, has been arranged by M. M. Leighton, chief, Illinois Geological Survey. There will also be a second symposium; and at a smoker George W. White, University of Illinois, will give the vice-presidential address. Section E will also have two sessions for contributed papers in geography. The *National Speleological Society* plans a regional meeting. The *National Geographic Society* will give its Annual Lecture Monday evening, December 29.

F—Zoological Sciences

The *Society of Systematic Zoology*—with 1100 members now one of the nation's largest zoological societies, concerned with all natural history phases of zoology—is holding its national meeting with the AAAS. In conjunction with *AAAS Section F* it will hold sessions for contributed papers in the mornings, book panels in the afternoons, and symposia of both technical and general interest in the evenings. The book panels will discuss two recent books on evolution and six recent texts in college biology and zoology; participants will include the authors and well-known zoologists, biochemists, psychologists, and paleontologists. Other zoological and science teaching societies will cosponsor appropriate sessions. The *Herpetologists League* will hold a symposium December 30 on the common names of reptiles and amphibians of the United States.

FG—Zoological and Botanical Sciences

The *National Association of Biology Teachers,* for which this is its annual national meeting, will hold nine sessions and a luncheon over a five-day period, the last two days being devoted to the NABT Conservation Project. The *American Nature Study Society,* at its annual national meeting with the AAAS, will hold four days of sessions, including a symposium on the Nature Study Movement and panels on Nature Photography and Nature in Radio, Television, Press, and Magazines; President Roger Tory Peterson will preside. The *Ecological Society of America,* for which this is one of its three regular meetings, will cosponsor the paper-reading sessions in plant and animal ecology of Sections F and G, a symposium on "The Western Range," of which F. W. Albertson, Fort Hays Kansas State College, is program chairman, and the *AAAS Section G* symposium "The American Midwest: I—The Cradle of Ecology; II—The Cradle of Conservation."

G—Botanical Sciences

In addition to the preceding symposium, *AAAS Section G* will have sessions for contributed papers in the principal fields of botany, a symposium in plant physiology cosponsored by the *Illinois and Purdue Chapters of the American Society of Plant Physiolo-*

gists and the *American Society of Naturalists,* arranged by Barry Commoner, Washington University.

H—Anthropology

AAAS Section H has planned sessions for contributed papers, symposia on "New Developments in Southwestern Archaeology," "The Plains and the Rio Grande Pueblos," and, with Section K, a four-session symposium on "World Plans for Technical Assistance."

I—Psychology

AAAS Section I has scheduled sessions for contributed papers, a symposium on "Problems in Psychotherapy," and a two-session symposium, "Men and Machines," of which Philip H. Du Bois, Washington University, is program chairman. As usual the vice-presidential addresses of Sections I and Q will be given jointly.

K—Social and Economic Sciences

AAAS Section K, in addition to the joint program with Section H, above, and with Section O, below, will hold a session on "Social Ecology," arranged by Amos Hawley, University of Michigan; will hold a joint session with the *American Statistical Association;* and will cosponsor a symposium with the *National Academy of Economics and Political Science.* The National Social Science Honor Society, *Pi Gamma Mu,* will collaborate and will hold its annual luncheon.

L—History and Philosophy of Science

The *Philosophy of Science Association* plans five sessions. *AAAS Section L* will cosponsor some of these, certain programs of Sections F and G, and is arranging programs on the methodology of industrial research and on the history of science, cosponsored by the *History of Science Society.*

M—Engineering

AAAS Section M, which suggested and will assist with the Disaster Recovery general symposium, will have a six-session symposium on "Cooperation between Science, Engineering and Industry;" will cosponsor a program being jointly arranged by the *St. Louis University Department of Engineering,* the *Washington University School of Engineering,* and the *Engineers' Club of St. Louis;* will cosponsor certain programs of AAAS Sections I, N, and P; and will cosponsor an important program on rail transportation which will be arranged by the *Association of American Railroads.* Topics included are The Railroad Laboratory at the Illinois Institute of Technology, Scientific and Engineering Aspects of Central Traffic Control, Diesel Operation, and the Economics of Electrification vs. Dieselization.

N—Medical Sciences

The *American Psychiatric Association* is arranging a special program under the direction of Jacob E. Finesinger, University of Maryland. *Alpha Epsilon Delta,* National Premedical Society, will hold its annual luncheon and is arranging a symposium. *AAAS Section N* is cosponsoring the symposia of Section I; the vice-presidential address will be given by William S. McCann, University of Rochester.

Nm—Medicine

AAAS Subsection Nm will have an exhibit on "Medicine and Instrumentation;" and will have symposia on "Industrial Hygiene and Toxicology," "Human Engineering," cosponsored by Section M, and another to be decided.

Nd—Dentistry

AAAS Subsection Nd will hold sessions for contributed papers and three symposia, "Scientific Aspects of Dental Filling Materials," "Engineering and Chemical Factors of Water Fluoridation," and "The Chemistry of Saliva;" there will also be a luncheon.

Np—Pharmacy

AAAS Subsection Np plans sessions for contributed papers from (*a*) pharmaceutical manufacturing firms, (*b*) accredited schools of pharmacy, and (*c*) pharmacy associations. It will have a symposium on "Newest Drug Therapy Agents." The *American Society of Hospital Pharmacists* and the *Scientific Section, American Pharmaceutical Association,* will cosponsor this program, of which George F. Archambault, U. S. Public Health Service, is chairman.

O—Agriculture

AAAS Section O, jointly with Section K, will have a four-session symposium on "Combined Resource Development with Special Reference to the Missouri Valley." The scope includes soils, vegetation, agriculture, minerals, hydrology, industrial development, investment, government. Charles E. Kellogg, chief, U. S. Soil Survey, program chairman, has received acceptances from distinguished authorities for each aspect; the treatment will be objective, with emphasis on scientific principles throughout.

P—Industrial Science

The *American Industrial Hygiene Association* will hold a regional meeting with the AAAS on December 30. The *Society for Industrial Microbiology,* for which this is one of its two regular meetings, will hold six or more sessions. A symposium and conference of industrial microbiologists is being arranged by J. E. McClary, director of research, Anheuser-Busch, Inc., which will be cosponsored by *AAAS Section P,* the Society for Industrial Microbiology, the *Mycological Society of America,* and the *St. Louis*

Academy of Science. The program of AAAS Section P is incomplete but is expected to surpass the excellent initial program of last year.

Q—Education

AAAS Section Q will have sessions for contributed papers, symposia on "Contributions of Education to Engineering and Industry," "Contributions of Engineering and Industry to Education," and a panel on "The Regents Examination System in New York." The first session, "An Evaluation of the New York State Regents Examinations in Science," will be cosponsored by the *AAAS Cooperative Committee on the Teaching of Science and Mathematics* and the *National Science Teachers Association*. The Cooperative Committee will also sponsor a meeting on the topic "The Identification of Talented Youth in Science and Mathematics," and is joining with the National Science Teachers Association, the National Association of Biology Teachers, and the American Nature Study Society in sponsoring several sessions devoted to a consideration of effective techniques for implementing science teaching objectives at the various levels of instruction, special methods for dealing with slow and with rapid learners, and desirable characteristics of science textbooks. The National Science Teachers Association, holding its four-day meeting with the AAAS, will have a series of sessions, including one on "Plans for the Future Scientists of America Foundation."

X—Science in General

The *Academy Conference*, with official delegates from most of the 38 academies of science affiliated with the AAAS, will hold two sessions devoted to round-table discussions of academy problems and a dinner; the retiring president, Clinton L. Baker, Southwestern College, will deliver an address on the history of the Academy Conference. The *St. Louis Academy of Science* will hold its December meeting with the AAAS. The *Conference on Scientific Manpower II* will hold sessions on three consecutive mornings on "Review and Assessment of Research on Scientific and Engineering Manpower," "Functions and Utilization of Rosters and Directories of Specialized Manpower," and "National Policies for Military Service." The program, under the chairmanship of Ralph M. Hogan, Human Resources Division, Office of Naval Research, will be cosponsored by the Engineering Manpower Commission and other agencies, including the AAAS Cooperative Committee. The *National Association of Science Writers* will hold its semiannual meeting with the AAAS and will have a program. The Annual Addresses or Lectures of the *National Geographic Society*, the *Scientific Research Society of America*, and the *Society of the Sigma Xi* have already been mentioned.

RAYMOND L. TAYLOR

Assistant Administrative Secretary, AAAS

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